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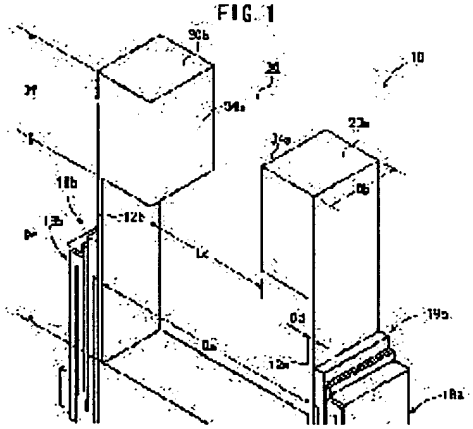
(54) PIEZOELECTRIC/ELECTROSTRICTIVE DEVICE AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To achieve weight reduction of a device, especially weight reduction of movable part or a fixing part and increase of displacement and high speed operation (high resonance frequency) of the movable part, and improve handling performance of the device and attaching property of components to the movable parts or fixing property of the device.

SOLUTION: In this piezoelectric/electrostrictive device 10, a pair of thin plates 12a and 12b which face each other, and the fixing part 14 for retaining the thin plates 12a and 12b are installed.

Piezoelectric/electrostrictive elements 18a and 18b are arranged on the



thin plates 12a and 12b, respectively. The movable parts 20a and 20b have end surfaces 34a and 34b which face each other, and the distance Lc between the end surfaces 34a and 34b is made greater than the length Df of the movable parts 20a and 20b.

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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The sheet metal section of the pair which carries out phase opposite, and the fixed part which supports these sheet metal section are provided. It has moving part in a part for the point of the sheet metal section of said pair. The inside of the sheet metal section of said pair, They are the piezo-electricity / electrostriction device which is the piezo-electricity / electrostriction device with which one or more piezo-electricity / electrostriction components were arranged in at least one sheet metal section, and either said moving part or a fixed part has the end face which counters mutually, and is characterized by the distance between said end faces being more than the die length of said moving part.
[Claim 2] The piezo-electricity / electrostriction device characterized by having the excision section in either said moving part or a fixed part, and said a part of excision section constituting said end face which counters mutually in piezo-electricity / electrostriction device according to claim 1.
[Claim 3] They are the piezo-electricity / electrostriction device characterized by consisting of ceramic bases which unify when said sheet metal section, said moving part, and said fixed part carry out coincidence baking of the ceramic Green layered product in piezo-electricity / electrostriction device according to claim 1 or 2, and come to excise a still more unnecessary part.
[Claim 4] They are the piezo-electricity / electrostriction device which said piezo-electricity / electrostriction component are film-like in piezo-electricity / electrostriction device according to claim 3, and is characterized by baking uniting with said ceramic base.
[Claim 5] The piezo-electricity / electrostriction device characterized by forming the opening between said end faces which counter mutually in piezo-electricity / electrostriction device given in any 1 term of claims 1-4.
[Claim 6] The piezo-electricity / electrostriction device which one of the configuration member, the same member, or two or more different members of said moving part or a fixed part intervene between said end faces which counter mutually, and is characterized by the area of said end face in said member and the field which counters being almost the same as the area of said end face in piezo-electricity / electrostriction device given in any 1 term of claims 1-5.
[Claim 7] The piezo-electricity / electrostriction device characterized by at least one member being organic resin among said two or more members in piezo-electricity / electrostriction device according to claim 6.
[Claim 8] The piezo-electricity / electrostriction device characterized by filling up with the gel ingredient in piezo-electricity / electrostriction device according to claim 6 or 7 in the pore formed with both the walls of the sheet metal section of said pair, the wall of said moving part, the wall of two or more of said members, and the wall of said fixed part.
[Claim 9] The piezo-electricity / electrostriction device with which internal residual stress produced for said sheet metal section, and/or said piezo-electricity / electrostriction component at the time of manufacture is characterized by having the structure released by forming said end face which counters mutually in piezo-electricity / electrostriction device given in any 1 term of claims 1-8.
[Claim 10] They are the piezo-electricity / electrostriction device characterized by having the electrode of a pair with which said piezo-electricity / electrostriction component were formed in piezo-electricity / electrostriction layer, and this the piezo-electricity / electrostriction layer in piezo-electricity / electrostriction device given in any 1 term of claims 1-9.

[Claim 11] Said piezo-electricity / electrostriction component are the piezo-electricity / electrostriction device characterized by the plurality of the electrode of said piezo-electricity / electrostriction layer, and said pair consisting of laminating gestalten in piezo-electricity / electrostriction device according to claim 10.
[Claim 12] The sheet metal section of the pair which carries out phase opposite, and the fixed part which supports these sheet metal section are provided. It has moving part in a part for the point of the sheet metal section of said pair. The inside of the sheet metal section of said pair, It is the manufacture approach of piezo-electricity / electrostriction device

that one or more piezo-electricity / electrostriction components were arranged in at least one sheet metal section. After producing said piezo-electricity / electrostriction component on said sheet metal at least, one predetermined part of the parts used as the part which serves as said moving part, or a fixed part is excised. The manufacture approach of of the piezo-electricity / electrostriction device characterized by having the process which forms said moving part or fixed part which has the end face which counters mutually and, by which distance between said end faces was carried out to more than the die length of said moving part.

[Claim 13] The sheet metal section of the pair which carries out phase opposite, and the fixed part which supports these sheet metal section are provided. It has moving part in a part for the point of the sheet metal section of said pair. The inside of the sheet metal section of said pair, The ceramic green sheet which is the manufacture approach of piezo-electricity / electrostriction device that one or more piezo-electricity / electrostriction components were arranged in at least one sheet metal section, and has a window part at least, The ceramic Green layered product containing the ceramic green sheet used as said sheet metal section is really calcinated behind. The ceramic layered product production process which produces a ceramic layered product, and the process which forms said piezo-electricity / electrostriction component in the outside surface of the part which serves as said sheet metal section among said ceramic layered products, By at least one excision processing to the ceramic layered product in which said piezo-electricity / electrostriction component were formed The manufacture approach of of the piezo-electricity / electrostriction device characterized by including the excision process which forms said moving part or fixed part which has at least said end face which counters mutually and, by which distance between said end faces was carried out to more than the die length of said moving part.

[Claim 14] In the manufacture approach of of piezo-electricity / electrostriction device according to claim 13 said ceramic layered product production process Two or more ceramic green sheets which have a window part for forming said moving part or fixed part which has the end face which counters mutually at least, The ceramic Green layered product containing the ceramic green sheet used as said sheet metal section is really calcinated behind, and said ceramic layered product is produced. Said excision process The manufacture approach of of the piezo-electricity / electrostriction device characterized by forming said moving part or fixed part by which it has at least said end face which counters mutually, and distance between said end faces was carried out to more than the die length of said moving part by the excision processing to the ceramic layered product in which said piezo-electricity / electrostriction component were formed.

[Claim 15] In the manufacture approach of of piezo-electricity / electrostriction device according to claim 13 or 14 said ceramic layered product production process Two or more ceramic green sheets which have a window part for forming the part used as the part which serves as said moving part where a part of end face which counters mutually at least was connected, or said fixed part, The ceramic Green layered product containing the ceramic green sheet used as said sheet metal section is really calcinated behind, and said ceramic layered product is produced. Said excision process By excision processing to said ceramic layered product in which said piezo-electricity / electrostriction component were formed The part used as the part which serves as said moving part where a part of end face which counters mutually at least was connected, or a fixed part is formed. Furthermore, the manufacture approach of of the piezo-electricity / electrostriction device characterized by forming said moving part or fixed part which has the end face which excises said joining segment and counters mutually and, by which distance between said end faces was carried out to more than the die length of said moving part.

[Claim 16] The manufacture approach of of the piezo-electricity / electrostriction device characterized by having the process which makes the configuration member of said moving part or a fixed part, and two or more different members intervene between said end faces which counter mutually in the manufacture approach of of piezo-electricity / electrostriction device given in any 1 term of claims 12-15.

[Claim 17] The manufacture approach of of the piezo-electricity / electrostriction device characterized by using organic resin as at least one member among said two or more members in the manufacture approach of of piezo-electricity / electrostriction device according to claim 16.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About piezo-electricity / electrostriction device equipped with the moving part which operates based on displacement actuation of piezo-electricity / electrostriction component or the piezo-electricity / electrostriction device which can detect the variation rate of moving part by piezo-electricity / electrostriction component, and its manufacture approach, in detail, this invention is excellent in reinforcement, shock resistance, and moisture resistance, and relates to the piezo-electricity / electrostriction device which can operate moving part greatly efficiently, and its manufacture approach.
[0002]
[Description of the Prior Art] Recently, in fields, such as optics, and magnetic recording, precision processing, the displacement component which can adjust the optical path length and a location is needed to submicron order, and development of the displacement component using the variation rate by the inverse piezoelectric effect and electrostrictive effect which are caused when an electrical potential difference is impressed to piezo-electricity / electrostriction ingredients (for example, ferroelectric etc.) is furthered.
[0003] Conventionally, as such a displacement component, as shown, for example in drawing 41 , by forming a pore 202 in the plate 200 which consists of piezo-electricity / an electrostriction ingredient, a fixed part 204, moving part 206, and the beam section 208 that supports these are formed in one, and the electrostrictive actuator which formed the electrode layer 210 in the beam section 208 is indicated further (for example, refer to JP,10-136665,A).
[0004] In said electrostrictive actuator, if an electrical potential difference is impressed to the electrode layer 210, it is possible at least for an arc status change to carry out the rotation variation rate of the moving part 206 into the field of a plate 200 according to an inverse piezoelectric effect or an electrostrictive effect, since the beam section 208 expands and contracts in the direction which connects a fixed part 204 and moving part 206.
[0005] The technique of performing highly precise positioning at a high speed is indicated, and the structure used making the bimorph of two sheets counter is shown to this official report (especially Fig. 4) by by dividing the electrode of that bimorph, preparing, and on the other hand, choosing and driving the divided electrode about the actuator which used bimorph for JP,63-64640,A.
[0006]
[Problem(s) to be Solved by the Invention] However, in said electrostrictive actuator, since the variation rate of the flexible direction (namely, field inboard of a plate 200) of piezo-electricity / electrostriction ingredient was transmitted to moving part 206 as it was, there was a problem that the travel of moving part 206 was small.
[0007] Moreover, since it constituted all parts with the piezo-electricity / electrostriction ingredient which is a brittle and comparatively heavy ingredient, the mechanical strength of the electrostrictive actuator was low, in addition to being inferior to handling nature, shock resistance, and moisture resistance, its electrostrictive actuator itself was heavy, and it had the trouble of being easy to be influenced on actuation of a harmful vibration (for example, residual vibration and noise vibration at the time of a fast operation).
[0008] In order to solve said trouble, filling up a pore 202 with the filler which has flexibility is proposed, but it is distinct that the amount of the variation rate by the inverse piezoelectric effect or the electrostrictive effect falls only by using a filler.
[0009] Furthermore, the actuator indicated by said JP,63-64640,A It adds to sticking bimorph to a holddown member or a junction member. Since it is the thing of the structure which comes to stick the two own piezo-electric child of bimorph, it is easy to remain the stress resulting from those attachment, heat-treatment, hardening contraction of adhesives concerning lamination, etc. with the internal residual stress Displacement actuation is barred and there is a

possibility that the variation rate as a design and resonance frequency may be unrealizable. Especially, when an actuator is small in size, the effect of adhesives will become large naturally.
[0010] Then, as an approach of eliminating the effect of the adhesives concerning attachment, an actuator is constituted from an one baking object of the ceramics, and it is possible to consider as the structure which does not use adhesives. However, a possibility that internal residual stress may occur must have been escaped also in this case by the difference in the heat shrink behavior of each part material at the time of baking.
[0011] Furthermore, when an actuator was small in size, it was inherent in the problem that the stability of the actuator and the attachment nature of other components to an actuator fall.
[0012] This invention is made in consideration of such a technical problem. Lightweight-izing of a device, While being able to raise the attachment nature of the components to moving part, or the stability of a device in the handling nature list of lightweight-izing of moving part or a fixed part, and a device and being able to displace moving part greatly by the low battery relatively by this especially Can make improvement in the speed (raise in resonance frequency) of a device, especially displacement actuation of moving part attain, moreover, are hard to be influenced of a harmful vibration, and a high-speed response is possible. A mechanical strength is high and it aims at offering the piezo-electricity / electrostriction device which can obtain the displacement component excellent in handling nature, shock resistance, and moisture resistance, and the sensor component which can detect vibration of moving part with a sufficient precision in a list, and its manufacture approach.
[0013]
[Means for Solving the Problem] This invention possesses the sheet metal section of the pair which carries out phase opposite, and the fixed part which supports these sheet metal section. It has moving part in a part for the point of the sheet metal section of said pair. The inside of the sheet metal section of said pair, It is the piezo-electricity / electrostriction device with which one or more piezo-electricity / electrostriction components were arranged in at least one sheet metal section, and either said moving part or a fixed part has the end face which counters mutually, and it is characterized by the distance between said end faces being more than the die length of said moving part.
[0014] Said moving part, a fixed part, and the sheet metal section may be constituted using the ceramics or a metal, can also constitute each part from ceramic ingredients, or can also constitute it from metallic materials. Furthermore, it can also constitute as hybrid construction which combined what was manufactured from the ceramics and a metaled ingredient.
[0015] And the excision section is prepared in either said moving part or a fixed part, and you may make it said a part of excision section constitute said end face which counters mutually. Furthermore, it unifies by carrying out coincidence baking of the ceramic Green layered product, and you may make it constitute said sheet metal section, said moving part, and said fixed part from a ceramic base which comes to excise a still more unnecessary part. Moreover, said piezo-electricity / electrostriction component are made into the shape of film, and you may make it unite with said ceramic base by baking.
[0016] In this case, said piezo-electricity / electrostriction component can have and constitute piezo-electricity / electrostriction layer, and the electrode of the pair formed in this piezo-electricity / electrostriction layer. Moreover, said piezo-electricity / electrostriction component have piezo-electricity / electrostriction layer, and the electrode of the pair formed in the both sides of this piezo-electricity / electrostriction layer, and you may make it form one electrode in said sheet metal section at least among the electrodes of this pair. In this case, vibration by piezo-electricity / electrostriction component can be efficiently transmitted to moving part or a fixed part through the sheet metal section, and improvement in responsibility can be aimed at. As for especially said piezo-electricity / electrostriction component, it is desirable that the plurality of the electrode of said piezo-electricity / electrostriction layer, and said pair consists of laminating gestalten.
[0017] While the generating force of piezo-electricity / electrostriction component increases and has and about is planned very much by making it such a configuration, high resonance frequency-ization is attained and there is the description that improvement in the speed of displacement actuation can be attained easily because the rigidity of the device itself increases.
[0018] It is good also as an opening and between said end faces which counter mutually And the member same between said end faces which counter mutually as the configuration member of either said moving part or a fixed part or two or more different members, Glass, cement, organic resin, etc. are mentioned. Preferably For example, organic resin, For example, you may make it make such mixture, such as an epoxy system, acrylic, a polyimide system, a phenol system, a silicone system, a terpene system, a xylene system, a styrene system, a melamine system, an methacrylic system, and a rubber system, or a copolymer intervene. It is desirable to make the organic resin of an epoxy system, acrylic, and an methacrylic system etc. intervene from points, such as junction nature, handling nature, and hardness, especially.

Furthermore, it is desirable to also make fillers, such as an inorganic material, mix in order to raise a degree of hardness.

[0019] It becomes possible to raise resonance frequency, without reducing the amount of displacement of moving part or a fixed part, since it can make a member lighter than the configuration member of said moving part or a fixed part able to intervene between said end faces which counter mutually or lightweight-ization of moving part or a fixed part can be effectively attained by joining between end faces by the small thing also by said member, when between said end faces which counter mutually was especially made into the opening.
[0020] Moreover, when between said end faces which counter mutually is made into an opening, a part of moving part containing one end face or fixed part, and moving part including an other-end side or another part of a fixed part becomes easy to bend, and it becomes strong to deformation. Therefore, it will excel in the handling nature of piezo-electricity / electrostriction device.
[0021] Furthermore, since the distance between end faces is more than the die length of said moving part, when attaching other components in moving part, the large clamp-face product can be taken and the attachment nature of components can be raised. Here, since considering the case where components are fixed with adhesives etc. it can hold on both sides of goods from both sides, components can be fixed certainly.
[0022] Furthermore, the height of the whole in which the height of goods and the height of moving part were no longer simply added, and included goods by holding on both sides of goods from both sides can be kept low. Furthermore, since the die length of moving part can be made smaller than the distance by the side of an end face, the physical properties of the adhesives on which components are pasted up can act effectively, and can enlarge a variation rate.
[0023] When it considers as the fixed part which has the end face which counters mutually on the other hand, it becomes possible to fix firmly the piezo-electricity / electrostriction device concerning this invention to a predetermined fixed portion, and improvement in dependability can be aimed at.
[0024] In this invention, the stability of the attachment nature of the components to moving part, a miniaturization, and a device can be raised also in lightweight-izing of a device in the handling nature of lightweight-izing of moving part or a fixed part, and a device, and a list. Thus, by this While being able to carry out the variation rate of the moving part greatly, can make improvement in the speed (raise in resonance frequency) of displacement actuation of moving part attain, moreover, are hard to be influenced of a harmful vibration, and a high-speed response is possible. A mechanical strength is high and the displacement component excellent in handling nature, shock resistance, and moisture resistance and the sensor component which can detect vibration of moving part with a sufficient precision in a list can be obtained.

[0025] By the way, in manufacture of piezo-electricity / electrostriction device, by baking etc., when piezo-electricity / electrostriction component is formed for example, in a ceramic layered product (what carried out the laminating of the ceramic green sheet, and really calcinated it), internal residual stress will really using lamination or the film forming method mentioned later occur into the part used as piezo-electricity / electrostriction component, and/or the sheet metal section, for example. Especially when really forming piezo-electricity / electrostriction component in a ceramic layered product by baking, it becomes easy to generate internal residual stress into the part which serves as piezo-electricity / electrostriction component, and/or the sheet metal section by the contraction of a configuration member and the difference in coefficient of thermal expansion which are produced at the time of baking.
[0026] If piezo-electricity / electrostriction device is produced and used from this condition, even if it gives predetermined electric field to the piezo-electricity / electrostriction layer which constitutes piezo-electricity / electrostriction component, a desired variation rate may not be shown in moving part. This is because the material property of piezo-electricity / electrostriction layer and displacement actuation of moving part are checked by the internal residual stress generated in piezo-electricity / electrostriction component, and/or said sheet metal section.
[0027] Since he is trying to prepare the end face which counters either moving part or a fixed part mutually, the distance between end faces will be shortened by this invention, for example with the internal residual stress generated in said piezo-electricity / electrostriction component, and/or the sheet metal section. That is, the internal residual stress produced in piezo-electricity / electrostriction component, and/or the sheet metal section will be released by migration of an end face.
[0028] Furthermore, in this invention, since he is trying to take a large distance between end faces, even if the distance between end faces narrows with internal residual stress, only allowances to attach other components between these end faces can be given.
[0029] Thus, in this invention, it is lost that displacement actuation of moving part is checked by said internal residual stress, and displacement actuation of the moving part as a design can be obtained mostly. In addition, improvement in the mechanical strength of a device can also be aimed at by release of this internal residual stress.

[0030] Moreover, when a pore is formed with both the walls of the sheet metal section of said pair, the wall of said moving part, the wall of two or more of said members, and the wall of said fixed part, you may make it filled up with a gel ingredient in this pore. in this case -- usually -- existence of a filler -- the variation rate of moving part -- the variation rate of lightweight-izing accompanying [although actuation will receive a limit] formation of the end face to moving part or a fixed part in above-mentioned invention, or moving part -- the variation rate of the moving part according to said filler since he is trying to attain increase-ization of an amount -- a limit of operation is negated and the effectiveness by existence of a filler, i.e., a raise in resonance frequency, and rigid reservation can be realized.
[0031] Next, this invention possesses the sheet metal section of the pair which carries out phase opposite, and the fixed part which supports these sheet metal section. It has moving part in a part for the point of the sheet metal section of said pair. The inside of the sheet metal section of said pair, It is the manufacture approach of piezo-electricity / electrostriction device that one or more piezo-electricity / electrostriction components were arranged in at least one sheet metal section. After producing said piezo-electricity / electrostriction component on said sheet metal at least, one predetermined part of the parts used as the part which serves as said moving part, or a fixed part is excised. It is characterized by having the process which forms said moving part or fixed part which has the end face which counters mutually and, by which distance between said end faces was carried out to more than the die length of said moving part.

[0032] the internal residual stress generated in piezo-electricity / electrostriction component, and/or the sheet metal section at the time of manufacture since the moving part or the fixed part which has the end face which counters mutually would be prepared -- the distance between end faces -- for example, it is released by being shortened -- ******** -- the variation rate of moving part -- actuation is not checked by said internal residual stress
[0033] After producing piezo-electricity / electrostriction component here, the condition that piezo-electricity / electrostriction layer was formed at least is shown, and after performing excision for forming the moving part or the fixed part which has the end face which counters mutually to the electrode formed after formation of piezo-electricity / electrostriction layer, you may make it form.
[0034] Moreover, without reducing the amount of displacement of moving part, since moving part or a fixed part is lightweight-ized by preparing the moving part or the fixed part which has the end face which counters mutually, the piezo-electricity / electrostriction device which becomes possible [raising resonance frequency] can be manufactured easily efficiently, and fertilization of the piezo-electricity / electrostriction device of high performance can be realized.
[0035] And in order to excel in the handling nature of piezo-electricity / electrostriction device since moving part or a fixed part becomes easy to bend and it becomes strong to deformation, and to make large existence of said end face which counters mutually, and distance between these end faces, when attaching other components in moving part, the large clamp-face product can be taken and the attachment nature of components can be raised. Moreover, a variation rate can be raised in case it pastes up on both sides of components.
[0036] Moreover, this invention possesses the sheet metal section of the pair which carries out phase opposite, and the fixed part which supports these sheet metal section. It has moving part in a part for the point of the sheet metal section of said pair. The inside of the sheet metal section of said pair, The ceramic green sheet which is the manufacture approach of piezo-electricity / electrostriction device that one or more piezo-electricity / electrostriction components were arranged in at least one sheet metal section, and has a window part at least, The ceramic Green layered product containing the ceramic green sheet used as said sheet metal section is really calcinated behind. The ceramic layered product production process which produces a ceramic layered product, and the process which forms said piezo-electricity / electrostriction component in the outside surface of the part which serves as said sheet metal section among said ceramic layered products, By at least one excision processing to the ceramic layered product in which said piezo-electricity / electrostriction component were formed It is characterized by including the excision process which forms said moving part or fixed part which has at least said end face which counters mutually and, by which distance between said end faces was carried out to more than the die length of said moving part.
[0037] This sets to manufacture of piezo-electricity / electrostriction device. Especially by baking Since the internal residual stress generated in piezo-electricity / electrostriction component, and/or the sheet metal section can be effectively released when piezo-electricity / electrostriction component is formed in a ceramic layered product, [when producing piezo-electricity / electrostriction device using a ceramic green sheet laminated layers method] The attachment nature of the components to moving part and the stability of a device can be raised in the handling nature of lightweight-izing of moving part or a fixed part, and a device, and a list, and, thereby, moving part can be displaced greatly also in lightweight-izing of a device.
[0038] And two or more ceramic green sheets which have a window part for said ceramic layered product production process to form said moving part or fixed part which has the end face which counters mutually at least, The ceramic

Green layered product containing the ceramic green sheet used as said sheet metal section is really calcinated behind, and said ceramic layered product is produced. Said excision process You may make it form said moving part or fixed part by which it has at least said end face which counters mutually, and distance between said end faces was carried out to more than the die length of said moving part by the excision processing to the ceramic layered product in which said piezo-electricity / electrostriction component were formed.

[0039] Moreover, two or more ceramic green sheets which have a window part for said ceramic layered product production process to form the part used as the part which serves as said moving part where a part of end face which counters mutually at least was connected, or said fixed part, The ceramic Green layered product containing the ceramic green sheet used as said sheet metal section is really calcinated behind, and said ceramic layered product is produced. Said excision process By excision processing to said ceramic layered product in which said piezo-electricity / electrostriction component were formed The part used as the part which serves as said moving part where a part of end face which counters mutually at least was connected, or a fixed part is formed. Furthermore, you may make it form said moving part or fixed part which has the end face which excises said joining segment and counters mutually and by which distance between said end faces was carried out to more than the die length of said moving part.

[0040] In addition, you may make it include the process which makes the configuration member of said moving part or a fixed part, and two or more different members intervene between said end faces which counter mutually. In this case, organic resin can be used as at least one member among said two or more members.

[0041] Therefore, according to the piezo-electricity / electrostriction device concerning this invention, and its manufacture approach Various transducers, various actuators, a frequency-domain functional part (filter), Others [active elements /, such as a transformer, the object for a communication link, the trembler for power or a resonator, a radiator, and a discriminator,], It can use as sensor components for [various] sensors, such as an ultrasonic sensor, an acceleration sensor and an angular-velocity sensor, and an impact sensor, a mass sensor. It can use suitable for the various actuators especially used for the variation rate of various precision components, such as an optical instrument and a precision mechanical equipment, etc., or the device of positioning adjustment and include-angle adjustment.

[0042]

[Embodiment of the Invention] Hereafter, the example of a gestalt of operation of the piezo-electricity / electrostriction device concerning this invention, and its manufacture approach is explained, referring to drawing 1 - drawing 40 .

[0043] Here, piezo-electricity / electrostriction device is concepts which include the component which changes electric energy and mechanical energy mutually by piezo-electricity / electrostriction component. Therefore, it is used most suitably as active elements, such as various actuators and vibrator, and a displacement component which used the variation rate by the inverse piezoelectric effect or the electrostrictive effect especially, and also may be suitably used as passive elements, such as an acceleration-sensor component and an impact sensor component.

[0044] As shown in drawing 1 , the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation possess the base 16 with which the sheet metal sections 12a and 12b of the pair which carries out phase opposite, and the fixed part 14 which supports these sheet metal sections 12a and 12b were formed in one, and piezo-electricity / electrostriction components 18a and 18b are formed, and it is constituted by the one section each of the sheet metal sections 12a and 12b of a pair, respectively.

[0045] That is, it has the configuration which the sheet metal sections 12a and 12b of a pair displace this piezo-electricity / electrostriction device 10 by the drive of said piezo-electricity / electrostriction component 18a, and/or 18b, or detects the variation rate of the sheet metal sections 12a and 12b by piezo-electricity / electrostriction component 18a, and/or 18b. Therefore, in the example of drawing 1 , the actuator sections 19a and 19b will consist of the sheet metal sections 12a and 12b, and piezo-electricity / electrostriction components 18a and 18b.

[0046] Furthermore, it will function as moving part 20a and 20b where a part for each point is made thick toward the inner direction, and this thick part displaces the sheet metal sections 12a and 12b of a pair with displacement actuation of the sheet metal sections 12a and 12b. Hereafter, a part for the point of the sheet metal sections 12a and 12b of a pair is described as moving part 20a and 20b.

[0047] In addition, about said base 16, although the whole was constituted using the ceramics or a metal, it is good also as hybrid construction which combined what was manufactured with the ingredient of others, the ceramics, and a metal.

[0048] Moreover, as for a base 16, it is desirable to constitute a base 16 from a ceramic layered product which could adopt the configuration of the metal integral construction unified by the structure of coming to paste up each part with adhesives, such as organic resin and glass, the ceramic integral construction which comes to unify a ceramic Green layered product by baking, low attachment, soldering, eutectic bonding, or welding, and unified the ceramic Green layered product by baking preferably.

[0049] Since a change of state with time hardly arises from not being placed between the joints of each part by

adhesives, such a unification object of the ceramics can be easily manufactured with the ceramic green sheet laminated layers method which the dependability like a joint mentions later in addition to being high and structure advantageous to rigid reservation.

[0050] And piezo-electricity / electrostriction components 18a and 18b will prepare piezo-electricity / electrostriction components 18a and 18b as an exception object as below-mentioned, and will be stuck on a base 16 by adhesives, such as organic resin and glass, low attachment, soldering, eutectic bonding, etc., and also they will be formed in said the direct base 16 instead of attachment by using the film forming method.

[0051] Piezo-electricity / electrostriction components 18a and 18b have piezo-electricity / electrostriction layer 22, and the electrodes 24 and 26 of the pair formed in the both sides of this piezo-electricity / electrostriction layer 22, and are constituted, and one electrode 24 is formed in the sheet metal sections 12a and 12b of a pair at least among the electrodes 24 and 26 of this pair.

[0052] With the gestalt of this operation, the electrodes 24 and 26 of a pair are made into multilayer structure at piezo-electricity / electrostriction layer 22 list, respectively. Although the case where it considers as the piezo-electricity / electrostriction components 18a and 18b which carry out the laminating of one electrode 24 and the electrode 26 of another side alternately, respectively so that it may become cross-section **** ctenidium-like and by which the part to which one [these] electrode 24 and the electrode 26 of another side lap on both sides of piezo-electricity / electrostriction layer 22 in between was considered as the multistage configuration is explained to a subject You may be not only multilayer structure but monolayer structure. In this case, although especially a multilayer number is not limited, ten or less layers are five or less layers desirable still more preferably.

[0053] Drawing 1 shows the example which made piezo-electricity / electrostriction layer 22 the three-tiered structure, formed in the shape of a ctenidium so that one electrode 24 might be located in the inferior surface of tongue (side face of the sheet metal sections 12a and 12b) of the 1st layer, and the top face of a two-layer eye, and was formed in the shape of a ctenidium so that the electrode 26 of another side might be located in the top face of the 1st layer, and the top face of the 3rd layer. Since the number of terminals 28 and 30 can be reduced in one electrode 24 list by carrying out the bond communalization of the electrode 26 comrades of another side, respectively in this configuration, enlargement of the size accompanying multilayering of piezo-electricity / electrostriction components 18a and 18b can be suppressed.

[0054] In addition, impression of the electrical potential difference to the electrodes 24 and 26 of a pair is performed through the terminals (pad) 28 and 30 formed on the both-sides side (component forming face) of a fixed part 14 among each electrodes 24 and 26, respectively. The terminal 28 corresponding to one electrode 24 in the location of each terminals 28 and 30 is formed in the back end approach of a fixed part 14, and the terminal 30 corresponding to the electrode 26 of another side by the side of outer space is formed in the wall approach of a fixed part 14.

[0055] In this case, immobilization of piezo-electricity / electrostriction device 10 can be separately performed using a field other than the field where terminals 28 and 30 have been arranged, respectively, and high dependability can be acquired as a result to the both sides of immobilization of piezo-electricity / electrostriction device 10, and the electrical installation between a circuit, a terminal 28, and 30. In this configuration, electrical installation of terminals 28 and 30 and a circuit is performed by a flexible printed circuit (called FPC), a flexible flat cable (called FFC), wirebonding, etc.

[0056] Thus, while the driving force of the actuator sections 19a and 19b increases and has and about is planned very much by using the piezo-electricity / electrostriction components 18a and 18b of multilayer structure, high resonance frequency-ization is attained and improvement in the speed of displacement actuation can attain easily because the rigidity of piezo-electricity / electrostriction device 10 the very thing increases.

[0057] In addition, what is necessary is just to decide a number of stages etc. suitably according to an application and a busy condition, in carrying out in order for power consumption to also increase in connection with it although increase of the driving force of the actuator sections 19a and 19b is achieved if a number of stages is made [many]. moreover, in the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation Even if it raises the driving force of the actuator sections 19a and 19b by using piezo-electricity / electrostriction components 18a and 18b, fundamentally Since the width of face (distance of Y shaft orientations) of the sheet metal sections 12a and 12b is eternal, For example, when applying to actuators, such as positioning of the magnetic head for hard disks used in a very narrow gap, and ringing control, it becomes a very desirable device.

[0058] As other examples of piezo-electricity / electrostriction components 18a and 18b For example, as shown in drawing 2 , the example which made piezo-electricity / electrostriction layer 22 5 layer structures, formed one electrode 24 in the shape of a ctenidium so that it might be located in the top face of the 1st layer, the top face of the 3rd layer, and the top face of the 5th layer, and formed the electrode 26 of another side in the shape of a ctenidium so that it might be located in the top face of a two-layer eye and the top face of the 4th layer may be shown.

[0059] Moreover, similarly piezo-electricity / electrostriction layer 22 is made into 5 layer structures, one electrode 24 is

formed in the shape of a ctenidium so that it may be located in the top face of the 1st layer, the top face of the 3rd layer, and the top face of the 5th layer, and you may make it form the electrode 26 of another side in the shape of a ctenidium so that it may be located in the inferior surface of tongue of the 1st layer, the top face of a two-layer eye, and the top face of the 4th layer as shown in drawing 3 .

[0060] In addition, impression of the electrical potential difference to the electrodes 24 and 26 of a pair is performed through the edge (it is hereafter described as terminal areas 24a and 26a) of each electrodes 24 and 26 formed on layer [5th] piezo-electricity / the electrostriction layer 22. Each terminal areas 24a and 26a are estranged and formed in extent which can be insulated electrically.

[0061] Although the case where it constituted from so-called sandwich structure which made piezo-electricity / electrostriction layer 22 intervene between the electrode 24 of a pair and 26 in above-mentioned piezo-electricity / electrostriction components 18a and 18b was shown In addition, as are shown in drawing 4 , and you may make it form the electrodes 24 and 26 of the pair of a tandem type in one principal plane of the piezo-electricity / electrostriction layer 22 formed in the side face of the sheet metal sections 12a and 12b at least and it is shown in drawing 5 The electrodes 24 and 26 of the pair of a tandem type are embedded in the piezo-electricity / electrostriction layer 22 formed in the side face of the sheet metal sections 12a and 12b at least, and you may make it form.

[0062] In the case of the structure shown in drawing 4 , there is an advantage that power consumption can be stopped low, and, in the case of the structure shown in drawing 5 , it becomes very advantageous to generating of an about from it being the structure where the inverse piezoelectric effect of the big direction of electric field of distortion and the generating force can be used effectively.

[0063] Specifically, the piezo-electricity / electrostriction components 18a and 18b which are shown in drawing 4 have the structure where come to form the electrodes 24 and 26 of the pair of tandem-type structure in one principal plane of piezo-electricity / electrostriction layer 22, and one electrode 24 and the electrode 26 of another side counter mutually with the gap 32 of fixed width of face alternately. Although drawing 4 showed the example which formed the electrodes 24 and 26 of a pair in one principal plane of piezo-electricity / electrostriction layer 22 In addition, may make it form the electrodes 24 and 26 of a pair between the sheet metal sections 12a and 12b, and the piezo-electricity / electrostriction layer 22, and You may make it form the electrodes 24 and 26 of the pair of a tandem type in the 1 principal-plane list of piezo-electricity / electrostriction layer 22, respectively between the sheet metal sections 12a and 12b, and the piezo-electricity / electrostriction layer 22.

[0064] On the other hand, the electrodes 24 and 26 of the pair of tandem-type structure are formed, and the piezo-electricity / electrostriction components 18a and 18b which are shown in drawing 5 have the structure where one electrode 24 and the electrode 26 of another side counter mutually with the gap 32 of fixed width of face alternately so that it may be embedded in piezo-electricity / electrostriction layer 22.

[0065] It can use suitable for the piezo-electricity / electrostriction device 10 which piezo-electricity / electrostriction components 18a and 18b as shown in such drawing 4 and drawing 5 also require for the gestalt of this operation. Like the piezo-electricity / electrostriction components 18a and 18b which are shown in drawing 4 and drawing 5 , when using the electrodes 24 and 26 of the pair of a tandem type, it is making small the pitch D of the ctenidium of each electrodes 24 and 26, and it is possible to enlarge the variation rate of piezo-electricity / electrostriction components 18a and 18b.

[0066] And the distance Lc between end-face 34a which counters mutually and 34b of moving part 20a and 20b As it is carried out to more than die-length (correctly die length of Z shaft orientations of moving parta [20] and 20b) Df of moving part 20a and 20b and is shown in drawing 1 between these end-faces 34a and 34b Like the piezo-electricity / electrostriction devices 10a and 10b concerning the 1st and 2nd modifications which you may make it make an opening (air) 36 intervene, and are shown in drawing 6 and drawing 7 You may make it make two or more members which consist of the same quality of the material as a configuration member or the different quality of the material of moving part 20a and 20b intervene among these end faces 34a and 34b. In this case, the end faces 34a and 34b which counter mutually [each moving part 20a and 20b] will function as clamp faces 34a and 34b.

[0067] The piezo-electricity / electrostriction device 10a concerning the 1st modification shown in drawing 6 show the case where set up the distance Lc between clamp-face 34a and 34b by about 1.5 times the die length Df of moving part 20a and 20b, and three spacing members 37A, 37B, and 37C of the thickness respectively almost same between clamp-face 34a and 34b are made to intervene.

[0068] The piezo-electricity / electrostriction device 10b concerning the 2nd modification shown in drawing 7 show the case where set up the distance Lc between clamp-face 34a and 34b by about 1.5 times the die length Df of moving part 20a and 20b, and one big spacing member 37 is pasted up between clamp-face 34a and 34b through adhesives 38.

[0069] Furthermore, in the piezo-electricity / electrostriction device 10b which starts the 2nd modification, for example,

as shown, for example in drawing 8 , it is desirable to make almost equal distance La and Lb from the medial axis n of a spacing member 37 to each end faces 34a and 34b.
[0070] In the piezo-electricity / electrostriction devices 10a and 10b concerning these 1st and 2nd modifications In three spacing member 37A - 37C (refer to drawing 6) lists, a spacing member 37 (refer to drawing 7) The configuration of a rectangular parallelepiped is presented mostly and the area of each side face (field which counters the moving part 20a and 20b of the sheet metal sections 12a and 12b) is set up almost similarly to the area of the clamp faces 34a and 34b in the moving part 20a and 20b of the sheet metal sections 12a and 12b.
[0071] Here, actuation of the piezo-electricity / electrostriction device 10b concerning the 2nd modification is explained. first, two piezo-electricity / electrostriction components 18a and 18b -- the natural condition 18a and 18b, i.e., piezo-electricity / electrostriction components, -- both -- a variation rate -- when not operating, it is shown in drawing 8 -- as -- the major axis (medial axis of a fixed part 14) m of piezo-electricity / electrostriction device 10b, and the medial axis n of a spacing member 37 -- about -- I am doing one.
[0072] From this condition, as shown, for example in the wave form chart of drawing 9 A, the sine wave Wa which has the predetermined bias potential Vb is applied to the electrodes 24 and 26 of the pair in one piezo-electricity / electrostriction component 18a, and as shown in drawing 9 B, the sine wave Wb from which about about 180 degrees of phases differ is applied to the electrodes 24 and 26 of the pair in the piezo-electricity / electrostriction component 18b of another side in said sine wave Wa.
[0073] And in the phase where the electrical potential difference of maximum was impressed as opposed to the electrodes 24 and 26 of the pair in one piezo-electricity / electrostriction component 18a, the piezo-electricity / electrostriction layer 22 in one piezo-electricity / electrostriction component 18a carry out contraction displacement in the direction of a principal plane. By this, as shown in drawing 10 , as shown in an arrow head A, to one sheet metal section 12a This sheet metal section 12a since the stress of the direction sagged rightward occurs, for example, one [this] sheet metal section 12a It bends rightward, and since it will be in the condition that the electrical potential difference is not impressed to the electrodes 24 and 26 of the pair in the piezo-electricity / electrostriction component 18b of another side, at this time, sheet metal section 12b of another side follows bending of one sheet metal section 12a, and bends rightward. Consequently, a spacing member 37 is displaced rightward as opposed to the major axis m of piezo-electricity / electrostriction device 10b in moving-part 20a and 20b list. In addition, the amount of displacement also becomes large, so that the amount of displacement changes according to the maximum of the electrical potential difference impressed to each piezo-electricity / electrostriction components 18a and 18b, for example, maximum becomes large.
[0074] When the piezo-electricity / electrostriction ingredient which has a high coercive electric field as a component of piezo-electricity / electrostriction layer 22 especially are applied, you may make it adjust said bias potential so that the level of the minimum value may turn into negative level slightly as shown in the wave of the two-dot chain line of drawing 9 A and drawing 9 B. In this case, the stress of the same direction occurs with the bending direction of one sheet metal section 12a in sheet metal section 12b of another side, and the drive of the piezo-electricity / electrostriction component (for example, piezo-electricity / electrostriction component 18b of another side) to which this negative level is impressed enables it to enlarge the amount of displacement of a spacing member 37 more at moving-part 20a and 20b list. That is, the piezo-electricity / electrostriction component 18b, or 18a to which negative level is impressed can give the function to consider as a support the piezo-electricity / electrostriction component 18a, or 18b which is the subject of displacement actuation, by using a wave as shown in the two-dot chain line in drawing 9 A and drawing 9 B.
[0075] Thus, it sets to the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation. In order for a variation rate with minute piezo-electricity / electrostriction components 18a and 18b to be amplified by big displacement actuation using bending of the sheet metal sections 12a and 12b and to transmit to moving part 20a and 20b, It becomes possible to carry out the variation rate of the moving part 20a and 20b greatly to the major axis m of piezo-electricity / electrostriction device 10b.
[0076] He is trying to establish especially the clamp faces 34a and 34b which counter mutually in moving part 20a and 20b with the gestalt of this operation. By in this case, the thing made for the member lighter than the configuration member of moving part 20a and 20b among said clamp faces 34a and 34b which counter mutually in making into an opening 36 between the clamp faces 34a and 34b which counter mutually to intervene It becomes possible to raise resonance frequency, without being able to attain effectively lightweight-ization of moving part 20a and 20b, and reducing the amount of displacement of moving part 20a and 20b.
[0077] Here, a frequency switches in alternation the electrical potential difference impressed to the electrodes 24 and 26 of a pair, and shows the frequency of the voltage waveform when carrying out the variation rate of the moving part 20a and 20b to right and left, and resonance frequency shows the maximum frequency which displacement actuation of

moving part 20a and 20b can follow by the predetermined oscillation mode.
[0078] Moreover, it sets to the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation. Since the fixed part 14 is united with moving part 20a and 20b, sheet metal section 12a, and 12b list and the piezo-electricity / electrostriction ingredient which is a brittle and comparatively heavy ingredient do not need to constitute all parts, A mechanical strength is high, is excellent in handling nature, shock resistance, and moisture resistance, and has on actuation the advantage of being hard to be influenced of a harmful vibration (for example, residual vibration and noise vibration at the time of a fast operation).
[0079] Furthermore, in the gestalt of this operation, when between the clamp faces 34a and 34b which counter mutually is made into an opening 36, moving-part 20a containing one clamp-face 34a and moving-part 20b containing clamp-face 34b of another side become easy to bend, and it becomes strong to deformation. Therefore, it will excel in the handling nature of piezo-electricity / electrostriction device 10.
[0080] Moreover, the surface area of moving part 20a and 20b becomes large by existence of said clamp faces 34a and 34b which counter mutually. Therefore, when attaching other components in moving part 20a and 20b, the large clamp-face product can be taken and the attachment nature of components can be raised. Here, goods will paste up components not only through the principal plane (a front face and/or tooth back) of moving part 20a and 20b but through the clamp faces 34a and 34b which counter mutually, considering the case where it fixes with adhesives etc., and components can be fixed certainly.
[0081] In the gestalt of this operation piezo-electricity / electrostriction components 18a and 18b Moreover, piezo-electricity / electrostriction layer 22, Since the electrodes 24 and 26 of the pair formed in the both sides of this piezo-electricity / electrostriction layer 22 are had and constituted and one electrode 24 was directly formed in the side face of the sheet metal sections 12a and 12b at least among the electrodes 24 and 26 of a pair Vibration by piezo-electricity / electrostriction components 18a and 18b can be efficiently transmitted to moving part 20a and 20b through the sheet metal sections 12a and 12b, and improvement in responsibility can be aimed at.
[0082] Moreover, he is trying to form continuously from a part of fixed part 14 in the gestalt of this operation, applying [to which the electrodes 24 and 26 of a pair lap on both sides of piezo-electricity / electrostriction layer 22 in between] it to a part of sheet metal sections 12a and 12b (substantial drive part 40), as shown, for example in drawing 1 . Although there is a possibility that deformation of said substantial drive part 40 and deformation of the sheet metal sections 12a and 12b may conflict, and it may become impossible for displacement actuation of moving part 20a and 20b to obtain a big variation rate when it forms in some moving part 20a and 20b further, having applied the substantial drive part 40 Since it forms with the gestalt of this operation so that said substantial drive part 40 may not be applied to both moving part 20a and 20b and the fixed part 14, Un-arranging [that displacement actuation of moving part 20a and 20b is restricted] is avoided, and the amount of displacement of moving part 20a and 20b can be enlarged.
[0083] On the contrary, when forming piezo-electricity / electrostriction components 18a and 18b in some moving part 20a and 20b, it is desirable to form so that said substantial drive part 40 may make it applied and located in a part of sheet metal sections 12a and 12b from some moving part 20a and 20b. This is because displacement actuation of moving part 20a and 20b will be restricted as mentioned above if the substantial drive part 40 is formed over a part of fixed part 14.
[0084] Although the above-mentioned example showed the example which established clamp faces 34a and 34b in moving part 20a and 20b, you may make it form end faces 34a and 34b in a fixed part 14 like the piezo-electricity / electrostriction device 10c concerning the 3rd modification shown in drawing 11 . The moving part 20a and 20b established in a part for the point of the sheet metal sections 12a and 12b of a pair in this case has the configuration connected with one, and the end faces 34a and 34b which counter a fixed part 14 mutually will be formed.
[0085] It becomes possible to fix firmly the piezo-electricity / electrostriction device 10c concerning this 3rd modification to a predetermined fixed portion in addition to the effectiveness in the case of having the clamp faces 34a and 34b which counter mutually by this the moving part 20a and 20b which mentioned above, and improvement in dependability can be aimed at. As for the die length of the substantial drive part 40, it is desirable to carry out to 20% - 95% of the die length of the sheet metal sections 12a and 12b, and it is still more desirable to consider as 40% - 80%.
[0086] Next, the desirable example of a configuration of the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation is explained.
[0087] First, in order to make displacement actuation of moving part 20a and 20b into a positive thing, it is desirable to make or more [of the thickness Dd of the sheet metal sections 12a and 12b] into 1/2 distance Dg which requires the substantial drive parts 40 of piezo-electricity / electrostriction components 18a and 18b for a fixed part 14 or moving part 20a and 20b.
[0088] and the ratio of the distance Da between the walls of the sheet metal sections 12a and 12b (distance of X shaft

orientations), and the width of face (distance of Y shaft orientations) Db of the sheet metal sections 12a and 12b -- it constitutes so that Da/Db may be set to 0.5-20. Aforementioned ratio Da/Db is preferably set to 1-15, and is set to 1-10 still more preferably. this ratio -- the default value of Da/Db -- the variation rate of moving part 20a and 20b -- it is the convention based on discovery of an amount being enlarged and being able to obtain dominantly the variation rate in a X-Z flat surface.

[0089] on the other hand -- the ratio of the die length (distance of Z shaft orientations) De of the sheet metal sections 12a and 12b, and the distance Da between the walls of the sheet metal sections 12a and 12b -- in De/Da, it is desirable for it to be preferably referred to as 0.5-10, and to be referred to as 0.5-5 still more preferably. this ratio -- the variation rate of the moving part 20a and 20b between which, as for the default value of De/Da, it was placed by the spacing member (37A-37C, and 37) -- resonance frequency high [that an amount can be enlarged] -- a variation rate -- it can operate -- ** (a high speed of response can be attained) -- it is the convention based on the discovery to say.

[0090] therefore, the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation -- the influence by Y shaft orientations -- a variation rate -- Or in order to consider as the structure of controlling vibration, and excelling in high-speed responsibility, and having a big variation rate by the low battery relatively a ratio -- Da/Db -- 0.5-20 -- carrying out -- and a ratio -- setting De/Da to 0.5-10 -- desirable -- further -- desirable -- a ratio -- Da/Db -- 1-10 -- carrying out -- and a ratio -- it is setting De/Da to 0.5-5.

[0091] Furthermore, in the piezo-electricity / electrostriction device 10b which starts the 2nd modification, for example, although a pore 42 will be formed with both the walls of the sheet metal sections 12a and 12b of a pair, the wall of moving part 20a and 20b, the wall (and wall of adhesives 38) of a spacing member 37, and the wall of a fixed part 14, it is desirable to fill up this pore 42, gel ingredient, for example, silicon gel. Usually, although displacement actuation of moving part 20a and 20b will receive a limit by existence of a filler Since he is trying to attain lightweight-izing and increase-izing of the amount of displacement of moving part 20a and 20b accompanying the formation of end faces 34a and 34b to moving part 20a and 20b in this 2nd modification, A limit of displacement actuation of the moving part 20a and 20b by said filler is negated, and the effectiveness by existence of a filler, i.e., a raise in resonance frequency, and rigid reservation can be realized.

[0092] Moreover, the short thing of the die length (distance of Z shaft orientations) Df of moving part 20a and 20b is desirable. It is because increase of lightweight-izing and resonance frequency is achieved by shortening. Furthermore, a variation rate can be raised in case goods are pinched. however -- in order to secure the rigidity of X shaft orientations of moving part 20a and 20b and to make the variation rate into a positive thing -- a ratio with the thickness Dd of the sheet metal sections 12a and 12b -- it is desirable to make Df/Dd or more into five preferably two or more.

[0093] In addition, the actual size of each part will be set to the reinforcement of the plane-of-composition product [for installation], and piezo-electricity / electrostriction devices, such as plane-of-composition product [for attaching the plane-of-composition product for installation of the components to moving part 20a and 20b and a fixed part 14 in other members], and terminal for electrodes, 10 whole, durability, and the required amount list of displacement in consideration of resonance frequency, driver voltage, etc.

[0094] 100 micrometers - 2000 micrometers are specifically desirable still more desirable, and the distance Da between the walls of the sheet metal sections 12a and 12b is 200 micrometers - 1600 micrometers. 50 micrometers - 2000 micrometers are desirable still more desirable, and the width of face Db of the sheet metal sections 12a and 12b is 100 micrometers - 500 micrometers. the thickness Dd of the sheet metal sections 12a and 12b -- the variation rate to Y shaft orientations -- the influence which is a component -- in relation with the width of face Db of the sheet metal sections 12a and 12b, it considers as Db>Dd and 2 micrometers - 100 micrometers are 10 micrometers - 80 micrometers desirable still more preferably so that a variation rate can control effectively.

[0095] 200 micrometers - 3000 micrometers are desirable still more desirable, and the die length De of the sheet metal sections 12a and 12b is 300 micrometers - 2000 micrometers. 50 micrometers - 2000 micrometers are 100 micrometers - 1000 micrometers desirable still more preferably, and the die length Df of moving part 20a and 20b is 200 micrometers - 600 micrometers more preferably.

[0096] Although the variation rate of Y shaft orientations does not exceed 10% to the variation rate of X shaft orientations by making it such a configuration, the extremely excellent effectiveness that a low-battery drive is possible by adjusting suitably in an above-mentioned dimension ratio and the range of an actual size, and the displacement component to Y shaft orientations can be controlled to 5% or less is shown. That is, moving part 20a and 20b will displace to 1 shaft orientations of X shaft orientations substantially, moreover, is excellent in high-speed responsibility, and can get a big variation rate by the low battery relatively.

[0097] Moreover, it sets to this piezo-electricity / electrostriction device 10. tabular [the tabular configuration of a device is / like before] (a variation rate -- the thickness of the direction which intersects perpendicularly with a direction

is small) -- not but Moving part 20a and 20b and a fixed part 14 are presenting the configuration (the thickness of the direction which intersects perpendicularly in the displacement direction is large) of a rectangular parallelepiped. Since the sheet metal sections 12a and 12b of a pair are formed so that the side face of moving part 20a and 20b and a fixed part 14 may continue, rigidity of Y shaft orientations of piezo-electricity / electrostriction device 10 can be alternatively made high.

[0098] That is, in this piezo-electricity / electrostriction device 10, only actuation of the moving part 20a and 20b within a flat surface (inside of XZ flat surface) can be generated alternatively, and the actuation within YZ side of moving part 20a and 20b (the so-called actuation of the influence direction) can be controlled.

[0099] Next, each component of the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation is explained.

[0100] As moving part 20a and 20b mentioned above, it is the part which operates based on the amount of drives of the sheet metal sections 12a and 12b, and various members are attached according to the purpose of using piezo-electricity / electrostriction device 10. For example, if it is the case where piezo-electricity / electrostriction device 10 is used as a displacement component, the shield of an optical shutter etc. will be attached, and if it is especially used for positioning and the ringing inhibition mechanism of the magnetic head of a hard disk drive, the member which needs positioning of the suspension which has the slider which has the magnetic head and the magnetic head, and a slider will be attached.

[0101] A fixed part 14 is a part which supports moving part 20a and 20b in sheet metal section 12a and 12b list as mentioned above, for example, when using for positioning of the magnetic head of said hard disk drive, whole piezo-electricity / electrostriction device 10 are fixed to a fixed plate or a suspension attached in the carriage arm attached in VCM (voice coil motor), and this carriage arm by carrying out support immobilization of the fixed part 14. Moreover, as shown in drawing 1 , the terminal 28 for driving piezo-electricity / electrostriction components 18a and 18b and the member of 30 and others may be arranged at this fixed part 14.

[0102] Although it is not limited as an ingredient which constitutes a fixed part 14 in moving-part 20a and 20b list especially as long as it has rigidity, the ceramics which can apply the ceramic green sheet laminated layers method mentioned later can be used suitably. Although the ingredient which uses zirconias including fully stabilized zirconia and partially stabilized zirconia, an alumina, a magnesia, silicon nitride, alumimium nitride, and titanium oxide as a principal component is specifically mentioned and also the ingredient which used such mixture as the principal component is mentioned, the ingredient with which a mechanical strength and toughness use a zirconia, especially fully stabilized zirconia as a principal component in a high point, and the ingredient which uses partially stabilized zirconia as a principal component are desirable. Moreover, in a metallic material, although it is not limited as long as it has rigidity, stainless steel, nickel, etc. are mentioned.

[0103] The sheet metal sections 12a and 12b are parts driven with the variation rate of piezo-electricity / electrostriction components 18a and 18b, as mentioned above. telescopic motion of the piezo-electricity / electrostriction components 18a and 18b which the sheet metal sections 12a and 12b are the members of the shape of sheet metal which has flexibility, and were arranged in the front face -- a variation rate -- crookedness -- it amplifies as a variation rate and has the function transmitted to moving part 20a and 20b. Therefore, if the configuration and the quality of the material of the sheet metal sections 12a and 12b have flexibility and have the mechanical strength of extent which is not damaged by flexion deformity, it is sufficient for them, and they can be suitably chosen in consideration of the responsibility of moving part 20a and 20b, and operability.

[0104] As for the thickness Dd of the sheet metal sections 12a and 12b, it is desirable to be referred to as 2 micrometers - about 100 micrometers, and it is [the thickness which doubled the sheet metal sections 12a and 12b, and the piezo-electricity / electrostriction components 18a and 18b] desirable to be referred to as 7 micrometers - 500 micrometers. As for the thickness of 0.1 micrometers - 50 micrometers, and the piezo-electricity / electrostriction layer 22, it is [the thickness of electrodes 24 and 26] desirable to be referred to as 3 micrometers - 300 micrometers.

[0105] By the ability using suitably the same ceramics as moving part 20a and 20b or a fixed part 14 as an ingredient which constitutes the sheet metal sections 12a and 12b, even if a zirconia, the ingredient which uses fully stabilized zirconia as a principal component especially, and the ingredient which uses partially stabilized zirconia as a principal component are thin meat, it is most suitably used from that a mechanical strength is large, that toughness is high, and reactivity with piezo-electricity / electrostriction layer, or electrode material being small.

[0106] Moreover, as an iron system ingredient, it is desirable to constitute from various stainless steel and various spring steel steel materials, and it is desirable, although to have flexibility and what is necessary is just the metallic material which can be deformed by flexion as above-mentioned, also when it constitutes from a metallic material preferably as a non-iron system ingredient to constitute from beryllium copper, phosphor bronze, nickel, and a ferronickel alloy.

[0107] That by which partial stabilization was carried out as follows in partially stabilized zirconia in the stabilization list at said fully-stabilized-zirconia list is desirable. That is, the stabilization of a zirconia made into the purpose is [add / not only addition of one kind of compound but / an oxidization yttrium, an oxidization ytterbium, cerium oxide, a calcium oxide, and a magnesium oxide being in a stabilization list as a compound which carries out partial stabilization, and adding one of compounds / them / and making a zirconia contain at least, or / combining these compounds] possible.

[0108] In addition, as an addition of each compound, if it is in the case of an oxidization yttrium or an oxidization ytterbium 1-30-mol % -- preferably, if it is in the case of 1.5-10-mol % and cerium oxide 6-50-mol % -- preferably, if it is in the case of 8-20-mol % and a calcium oxide, or a magnesium oxide Although it is desirable % and to 5-40-mol consider as 5-20-mol % preferably, also especially in it, it is desirable to use yttrium oxide as a stabilizing agent, and it is desirable % and to 1.5-10-mol consider as 2-4-mol % still more preferably in that case. Moreover, although it is possible to add an alumina, a silica, a transition-metals oxide, etc. in 0.05 - 20wt% as additives, such as sintering acid, when adopting the baking unification by the film forming method as the formation technique of piezo-electricity / electrostriction components 18a and 18b, it is also desirable to add an alumina, a magnesia, a transition-metals oxide, etc. as an additive.

[0109] In addition, it is desirable to set preferably 0.05-3 micrometers of average crystal particle diameter of a zirconia to 0.05-1 micrometer so that a mechanical strength and the stable crystal phase may be obtained. Moreover, although the same ceramics as a fixed part 14 can be used for moving-part 20a and 20b list about the sheet metal sections 12a and 12b as mentioned above, constituting preferably using the same ingredient substantially is advantageous when aiming at reduction of the dependability for a joint, the reinforcement of piezo-electricity / electrostriction device 10, and the complicatedness of manufacture.

[0110] Although piezo-electricity / electrostriction components 18a and 18b have the electrodes 24 and 26 of the pair for applying electric field to piezo-electricity / electrostriction layer 22, and this the piezo-electricity / electrostriction layer 22 at least and piezo-electricity / electrostriction components, such as a uni-morph mold and a bimorph mold, can be used for them It excels in the stability of the amount of displacement to generate, and since it is advantageous to lightweight-izing, the direction of the uni-morph mold combined with the sheet metal sections 12a and 12b is suitable for such piezo-electricity / an electrostriction device 10.

[0111] Said piezo-electricity / electrostriction components 18a and 18b have the desirable direction formed in the side face of the sheet metal sections 12a and 12b at the point that the sheet metal sections 12a and 12b can be made to drive more greatly, as shown in drawing 1 .

[0112] Although electrostrictive ceramics is suitably used for piezo-electricity / electrostriction layer 22, it is also possible to use the electrostriction ceramics, the ferroelectric ceramics, or the antiferroelectric crystal ceramics. However, since linearity with the amount of displacement of moving part 20a and 20b, driver voltage, or output voltage is made important when using this piezo-electricity / electrostriction device 10 for positioning of the magnetic head of a hard disk drive etc., it is desirable to use the small ingredient of distortion hysteresis, and it is desirable that a coercive electric field uses an ingredient 10kV [/mm] or less.

[0113] The ceramics which is independent or contains lead zirconate, lead titanate, magnesium niobic acid lead, nickel niobic acid lead, zinc niobic acid lead, manganese niobic acid lead, antimony stannic-acid lead, a manganese lead wolframate, cobalt niobic acid lead, barium titanate, a titanic-acid sodium bismuth, niobic acid potassium sodium, a tantalic acid strontium bismuth, etc. as mixture as a concrete ingredient is mentioned.

[0114] Especially, it has a high electromechanical coupling coefficient and a high piezoelectric constant, and reactivity with the sheet metal sections 12a and 12b at the time of sintering of piezo-electricity / electrostriction layer 22 (ceramics) is small, and the ingredient which uses lead zirconate, lead titanate, and magnesium niobic acid lead as a principal component, or the ingredient which uses a titanic acid sodium bismuth as a principal component is suitably use in the point that the thing of the stable presentation is obtain.

[0115] Furthermore, the ceramics which is independent or mixed oxides, such as a lanthanum, calcium, strontium, molybdenum, a tungsten, barium, niobium, zinc, nickel, manganese, a cerium, cadmium, chromium, cobalt, antimony, iron, an yttrium, a tantalum, a lithium, a bismuth, and tin, etc. into said ingredient may be used.

[0116] For example, an advantage, like adjustment of a coercive electric field and a piezo-electric property is attained can be acquired by making the lead zirconate, lead titanate, and magnesium niobic acid lead which are a principal component contain a lanthanum and strontium.

[0117] In addition, as for addition of ingredients which are easy to vitrify, such as a silica, avoiding is desirable. It is because ingredients, such as a silica, tend to react with piezo-electricity / electrostriction ingredient at the time of heat treatment of piezo-electricity / electrostriction layer 22, the presentation is fluctuated and a piezo-electric property is

degraded.
[0118] On the other hand, the electrodes 24 and 26 of the pair of piezo-electricity / electrostriction components 18a and 18b Are a solid-state at a room temperature and it is desirable to consist of metals excellent in conductivity. For example, aluminum, titanium, chromium, iron, cobalt, nickel, copper, Zinc, niobium, molybdenum, a ruthenium, palladium, a rhodium, silver, Metal simple substances, such as tin, a tantalum, a tungsten, iridium, platinum, gold, and lead, or these alloys are used, and the cermet ingredient which made these distribute the same ingredient as piezo-electricity / electrostriction layer 22, or the sheet metal sections 12a and 12b further may be used.
[0119] It opts for the material selection of the electrodes 24 and 26 in piezo-electricity / electrostriction components 18a and 18b depending on the formation approach of piezo-electricity / electrostriction layer 22. For example, when forming piezo-electricity / electrostriction layer 22 by baking on one [this] electrode 24 after forming one electrode 24 on sheet metal section 12a and 12b Although it is necessary to use refractory metals, such as platinum which does not change in the burning temperature of piezo-electricity / electrostriction layer 22, palladium, a platinum-palladium alloy, and a silver-palladium alloy, for one electrode 24 After forming piezo-electricity / electrostriction layer 22, since the electrode 26 of another side of the outermost layer formed on this piezo-electricity / electrostriction layer 22 can perform electrode formation at low temperature, low melting point metals, such as aluminum, gold, and silver, can be used for it as a principal component.
[0120] Moreover, as for the thickness of electrodes 24 and 26, it is desirable to use ingredients, such as the organic metal paste with which the precise and thinner film is obtained after baking, for example, a golden resinate paste, a platinum resinate paste, and a silver resinate paste, for the electrode in which the factor which reduces the variation rate of piezo-electricity / electrostriction components 18a and 18b not a little is formed after baking of a sake, especially the piezo-electricity / electrostriction layer 22.
[0121] Although the above-mentioned example showed the case where thickness of moving part 20a and 20b formed in a part for the point of the sheet metal sections 12a and 12b at one was made thicker than the thickness Dd of the sheet metal sections 12a and 12b In addition, like the piezo-electricity / electrostriction device 10d concerning the 4th modification shown in drawing 12 , even if almost the same as the thickness Dd of the sheet metal sections 12a and 12b in the thickness of moving part 20a and 20b, it is good. Thereby, when attaching goods in moving part 20a and 20b, it becomes possible to attach so that the goods of the magnitude equivalent to the distance between sheet metal section 12a and 12b may be put between moving-part 20a and 20b. In this case, the adhesives field (for example, adhesives 38 of drawing 7) for attaching goods will correspond to moving part 20a and 20b.
[0122] And piezo-electricity / electrostriction device 10 can be used suitable for various sensors, such as an ultrasonic sensor, an acceleration sensor and an angular-velocity sensor, and an impact sensor, a mass sensor, and has the further advantage that sensitivity settling of a sensor can be performed easily, by adjusting suitably the size of the body attached between end faces 34a and 34b thru/or sheet metal section 12a, and 12b.
[0123] Next, it explains, referring to drawing 13 - drawing 15 about the piezo-electricity / electrostriction devices 10e-10g concerning the 5th as a gestalt of more desirable operation of this invention - the 7th modification.
[0124] First, although the piezo-electricity / electrostriction device 10e concerning the 5th modification have the almost same configuration as the piezo-electricity / electrostriction device 10 explained until now as shown in drawing 13 , the configurations of piezo-electricity / electrostriction components 18a and 18b etc. differ in respect of the following.
[0125] That is, piezo-electricity / electrostriction layer 22 is made into 4 layer structures, piezo-electricity / electrostriction components 18a and 18b are formed in the shape of a ctenidium so that one electrode 24 may be located in the top face of the 1st layer, and the top face of the 3rd layer, and they are formed in the shape of a ctenidium so that the electrode 26 of another side may be located in the inferior surface of tongue of the 1st layer, the top face of a two-layer eye, and the top face of the 4th layer.
[0126] It is formed mostly continuously, especially covering [of another side located in the inferior surface of tongue of the 1st layer / 26] it over each side face of the sheet metal sections 12a and 12b, moving part 20a and 20b, and a fixed part 14, and further, it is detached in part in the side face of a fixed part 14, and constitutes the slit 70.
[0127] The meaning which formed this slit 70 does not make the actuator in the back end section 72 (part from the back end side edge section of a slit 70 to the back end of a fixed part 14) of **:piezo-electricity / electrostriction components 18a and 18b drive, ** : it is making a short circuit hard to produce at the edge of one terminal 28, and arranging an electrode material on the inferior surface of tongue of the piezo-electricity / electrostriction layer 22 in the back end section of **:piezo-electricity / electrostriction components 18a and 18b.
[0128] In addition, in the case which is not desirable on the contrary, forming a slit 70 does not necessarily need to form a slit 70, and it may omit it.
[0129] If shown in drawing 13 , the thickness Dd of the sheet metal sections 12a and 12b here 0.05mm, The distance Dh

from the side face of one sheet metal section 12a to the side face of sheet metal section 12b of another side 1.3mm, The die length Di (the die length of the fixed part 14 in alignment with shaft orientations (piezo-electricity / electrostriction device 10f)) of a fixed part 14 0.4mm, The die length Df of moving part 20a and 20b the width of face Dj of 0.3mm and moving part 20a and 20b 0.25mm, The die length Dm (distance from the tip of moving part 20a and 20b to the back end of a fixed part 14) of the whole (0.05mm, and piezo-electricity / electrostriction device 10f) of the amount Dk of protrusions of moving part 20a and 20b is 1.9mm. The case where the minimum distance between end-face 34a and 34b (it is equivalent to the distance Lc of drawing 1) is 1.04mm is shown.

[0130] The dimension of each part is controlled in **10% of range to an above-mentioned dimension, and if moving part 20a and 20b is connected by the spacing member 37 of the same quality of the material as a configuration member as shown in drawing 7 between end-face 34a and 34b in this case, the resonance frequency of 45**10kHz, and the piezo-electricity / electrostriction device beyond displacement 0.5micrometer (30Vpp) will be obtained.

[0131] Although drawing 13 shows that each end face of the piezo-electricity / electrostriction layer 22 of 4 layer structure is arranged, it is desirable to make it go to the method of inside gradually as it becomes the upper layer about the end face of piezo-electricity / electrostriction layer 22, and to prepare a level difference.

[0132] Next, the piezo-electricity / electrostriction device 10f concerning the 6th modification, although it has the almost same configuration as the piezo-electricity / electrostriction device 10e concerning the 5th modification as shown in drawing 14 , the configurations of piezo-electricity / electrostriction components 18a and 18b differ in respect of the following.

[0133] That is, piezo-electricity / electrostriction layer 22 is made into a three-tiered structure, piezo-electricity / electrostriction components 18a and 18b are formed in the shape of a ctenidium so that one electrode 24 may be located in a part of inferior surface of tongue of the 1st layer, and the top face of a two-layer eye, and they are formed in the shape of a ctenidium so that the electrode 26 of another side may be located in a part of inferior surface of tongue of the 1st layer, the top face of the 1st layer, and the top face of the 3rd layer.

[0134] While is especially located in the inferior surface of tongue of the 1st layer. An electrode 24 and another side an electrode 26 The electrode of another side which is separated through the slit 70 in a part of sheet metal sections 12a and 12b, and is located in the inferior surface of tongue of the 1st layer While is located in the inferior surface of tongue of the 1st layer, and it is continuously applied and formed in the upper limit of moving part 20a and 20b from a slit 70, and is continuously formed from the slit 70, covering [24] it over the back end of a fixed part 14.

[0135] Next, the piezo-electricity / electrostriction device 10g concerning the 7th modification, although it has the almost same configuration as the piezo-electricity / electrostriction device 10f concerning the 6th modification as shown in drawing 15 , the formation patterns of the electrodes 24 and 26 of a pair differ in respect of the following.

[0136] That is, one electrode 24 is formed in the shape of a ctenidium so that it may be located in the inferior surface of tongue of the layer [1st] piezo-electricity / the electrostriction layer 22, and the top face of a two-layer eye, and the electrode 26 of another side is formed in the shape of a ctenidium so that it may be located in the top face of the layer [1st] piezo-electricity / the electrostriction layer 22, and the top face of the 3rd layer.

[0137] Especially, while is located in the inferior surface of tongue of the 1st layer, and it is continuously formed in each side face of the sheet metal sections 12a and 12b, moving part 20a and 20b, and a fixed part 14, covering an electrode 24.

[0138] If the difference between the piezo-electricity / electrostriction device 10f concerning the 6th modification is explained here, the piezo-electricity / electrostriction device 10f concerning the 6th modification As shown in drawing 14 , from both one electrode 24 and the electrode 26 of another side being formed on sheet metal section 12a In the both ends (edge corresponding to the back end of the edge corresponding to the tip of moving part 20a and 20b, and a fixed part 14) of piezo-electricity / electrostriction components 18a and 18b, the electrodes 24 and 26 with which the polarity was mutually made reverse will be located.

[0139] On the other hand, in the piezo-electricity / electrostriction device 10g concerning the 7th modification, since only one electrode 24 is formed on sheet metal section 12a and 12b as shown in drawing 15 , in the both ends of piezo-electricity / electrostriction components 18a and 18b, the electrode 24 with which the polarity was mutually made the same will be located. The polar description of these edges will be used combining suitably the circuit where piezo-electricity / electrostriction device 10g is used.

[0140] Moreover, in the piezo-electricity / electrostriction device 10f concerning the 6th modification, although the substantial drive parts of piezo-electricity / electrostriction components 18a and 18b are parts with which the electrodes 24 and 26 of a pair lap, as shown in drawing 14 , they are parts with which the electrodes 24 and 26 formed in each class of piezo-electricity / electrostriction layer 22 lap, and are kinds of the part shown in the range C.

[0141] On the other hand, the substantial drive part (piezo-electricity / electrostriction device 10g) concerning the 7th

modification The part with which the electrodes 24 and 26 formed in each class of piezo-electricity / electrostriction layer 22 lap (part shown in the range C), While was formed in the top face of the piezo-electricity / electrostriction layer 22 of a two-layer eye, and it is located in the moving-part 20a and 20b side rather than the edge of an electrode 24. It is two sorts of a part (part shown in the range D) with which the electrodes 24 and 26 of a pair lap through layer [1st] piezo-electricity / the electrostriction layer 22, and the description is in the place where the part shown in the range D also serves as a driving source.

[0142] Next, some manufacture approaches of of the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation are explained, referring to drawing 16 - drawing 40 .

[0143] The piezo-electricity / electrostriction device 10 concerning the gestalt of this operation The component of each part material is used as the ceramics. As a component of piezo-electricity / electrostriction device 10 The base 12a and 16 12b except piezo-electricity / electrostriction components 18a and 18b, i.e., the sheet metal sections, It is desirable to use and manufacture a ceramic green sheet laminated layers method about moving part 20a and 20b in fixed part 14 list, and, on the other hand, it makes the start piezo-electricity / electrostriction components 18a and 18b. About each terminals 28 and 30, it is desirable to manufacture using the film formation technique, such as a thin film and a thick film.

[0144] According to the ceramic green sheet laminated layers method which can fabricate each part material in the base 16 of piezo-electricity / electrostriction device 10 in one, since the change of state of the joint of each part material with time hardly arises, the dependability like a joint is a high and approach advantageous to rigid reservation.

[0145] the piezo-electricity / electrostriction device 10 concerning the gestalt of this operation -- the boundary partial (part for joint) list of the sheet metal sections 12a and 12b and a fixed part 14 -- the boundary part (a part for a joint) of the sheet metal sections 12a and 12b and moving part 20a and 20b -- a variation rate -- since it becomes the supporting point of a manifestation, the dependability for a joint is the important point which influences the property of piezo-electricity / electrostriction device 10.

[0146] since [moreover,] the manufacture approach shown below is excellent in productivity or a moldability -- the piezo-electricity / electrostriction device 10 of a predetermined configuration -- a short time -- and it can obtain with sufficient repeatability.

[0147] Hereafter, the 1st manufacture approach of of the piezo-electricity / electrostriction device 10 concretely applied to the gestalt of this operation is explained. Here, the definition is carried out. The layered product obtained by carrying out the laminating of the ceramic green sheet is defined as the ceramic Green layered product 58 (for example, refer to drawing 17). What calcinated this ceramic Green layered product 58, and was unified is defined as the ceramic layered product 60 (for example, refer to drawing 18). The thing which excises an unnecessary part from this ceramic layered product 60 and by which the fixed part 14 was united with moving part 20a and 20b, sheet metal section 12a, and 12b list is defined as ceramic base 16C (refer to drawing 19).

[0148] Moreover, in this 1st manufacture approach, it is the gestalt which has arranged two or more piezo-electricity / electrostriction devices 10 in the lengthwise direction and the longitudinal direction in the same substrate, respectively, and, finally the ceramic layered product 60 is cut per chip, and although many piezo-electricity / electrostriction devices 10 are taken and are carried out at the same process, in order to simplify explanation, it explains by making one - piece picking of piezo-electricity / electrostriction device 10 into a subject.

[0149] First, addition mixing of a binder, a solvent, a dispersant, the plasticizer, etc. is carried out at ceramic powder, such as a zirconia, a slurry is produced, and the ceramic green sheet which has predetermined thickness for this by approaches, such as the reverse roll coater method and a doctor blade method, after degassing processing is produced.

[0150] Next, by approaches using metal mold, such as blanking and laser beam machining, a ceramic green sheet is processed into various configurations like drawing 16 , and the ceramic green sheets 50A-50I for base formation of two or more sheets, and 52A and 52B are obtained.

[0151] These ceramic green sheets 50A-50I, and 52A and 52B have the ceramic green sheets 50A-50I of two or more sheets (for example, nine sheets) with which the window part 54 for forming space between sheet metal section 12a and 12b at least was formed, and the ceramic green sheets 52A and 52B of two or more sheets (for example, two sheets) which serve as the sheet metal sections 12a and 12b behind. In addition, the number of sheets of a ceramic green sheet is an example to the last.

[0152] Then, as shown in drawing 17 , as the ceramic green sheets 50A-50I are put with the ceramic green sheets 52A and 52B, a laminating and after being stuck by pressure and considering as the ceramic Green layered product 58, this ceramic Green layered product 58 is calcinated for these ceramic green sheets 50A-50I, and 52A and 52B, and the ceramic layered product 60 (refer to drawing 18) is obtained.

[0153] In addition, the count of sticking by pressure or sequence for laminating unification are not limited. It can be

decided suitably that desired structure is acquired by the configuration of a window part 54, the number of sheets of a ceramic green sheet, etc., corresponding to structure.
[0154] Not all the configurations of a window part 54 need to be the same, and can be determined according to a desired function. Moreover, the number of sheets of a ceramic green sheet and especially the thickness of each ceramic green sheet are not limited, either.
[0155] Sticking by pressure can raise laminating nature more by applying heat. Moreover, the laminating nature of a ceramic green sheet interface can be raised by applying and printing a paste, a slurry, etc. which made the subject ceramic powder (desirable in respect of the same as that of the ceramics used for the ceramic green sheet, or the dependability reservation by it being a similar presentation), and a binder on a ceramic green sheet, and considering as a junction auxiliary layer. In addition, it is desirable to deal with it using the polyethylene terephthalate film with which the ceramic green sheets 52A and 52B coated the front face with the release agent of a silicone system also in plastic film when thin.
[0156] Next, as shown in drawing 18 , piezo-electricity / electrostriction components 18a and 18b are formed in both the front faces of said ceramic layered product 60, i.e., the front face on which the ceramic green sheets 52A and 52B are equivalent to the front face by which the laminating was carried out, respectively. As a method of forming piezo-electricity / electrostriction components 18a and 18b, the thin film forming methods, such as the thick-film forming methods, such as screen printing, a dipping method, the applying method, and an electrophoresis method, the ion beam method and the sputtering method, vacuum deposition, the ion plating method, a chemical-vapor-deposition method (CVD), and plating, can be used.
[0157] Integration can be made easy, while being able to join and arrange piezo-electricity / electrostriction components 18a and 18b, and the sheet metal sections 12a and 12b in one and being able to secure dependability and repeatability, without using adhesives by forming piezo-electricity / electrostriction components 18a and 18b using such a film forming method.
[0158] In this case, it is desirable to form piezo-electricity / electrostriction components 18a and 18b by the thick-film forming method. It is because good piezo-electricity / electrostriction property can be acquired by being able to film-ize the particle of 0.05-3-micrometer electrostrictive ceramics, and powder the mean particle diameter of 0.01-5 micrometers using the paste used as a principal component, a slurry or a suspension, an emulsion, a sol, etc. preferably, and calcinating it if the thick-film forming method is especially used in formation of piezo-electricity / electrostriction layer 22.
[0159] In addition, an electrophoresis method has the advantage that it is a high consistency and the film can be formed in a high configuration precision. Moreover, since film formation and pattern formation are made as for screen printing to coincidence, it is advantageous to simplification of a production process.
[0160] Concretely, formation of piezo-electricity / electrostriction components 18a and 18b is explained. First, the ceramic Green layered product 58 is calcinated at the temperature of 1200 degrees C - 1600 degrees C. After unifying and obtaining the ceramic layered product 60, one [of the sheet metal sections 12a and 12b] 1st electrode 24 is printed and calcinated in the predetermined location of both the front faces of this ceramic layered product 60. Subsequently Print and calcinate piezo-electricity / electrostriction layer 22, and one [said] 1st electrode 24 and the electrode 26 of another side which makes a pair are printed further. It calcinates, and these are repeated the number of predetermined times (when piezo-electricity / electrostriction components 18a and 18b consist of multilayer piezo-electricity / electrostriction layer 22), and piezo-electricity / electrostriction components 18a and 18b are formed. Then, the terminals 28 and 30 for connecting each electrodes 24 and 26 to a drive circuit electrically are printed and calcinated.
[0161] Moreover, one [of the lowest layer] 1st electrode 24 is printed and calcinated, piezo-electricity / electrostriction layer 22, one 1st electrode 24, and the electrode 26 of the 1st another side which makes a pair are printed and calcinated, only the count of predetermined may repeat printing and baking in this unit, and piezo-electricity / electrostriction components 18a and 18b may be formed.
[0162] here -- as one electrode 24 -- as platinum (Pt) piezo-electricity / electrostriction layer 22 -- as PZT (PZT) and the electrode 26 of another side -- gold (Au) -- further -- as terminals 28 and 30 -- silver (Ag) -- as -- If an ingredient is selected so that the burning temperature of each part material may become low according to the order of a laminating, in a certain baking phase, resintering of the ingredient calcinated from it before does not happen, but generating of the fault of exfoliation and condensation of electrode material etc. can be avoided.
[0163] In addition, by choosing a suitable ingredient, each part material and terminals 28 and 30 of piezo-electricity / electrostriction components 18a and 18b are printed serially, really calcinating at once is also possible, and after forming the piezo-electricity / electrostriction layer 22 of the outermost layer, the electrode 26 grade of the outermost layer can also be prepared at low temperature.

[0164] Moreover, each part material and terminals 28 and 30 of piezo-electricity / electrostriction components 18a and 18b may be formed by the thin film forming methods, such as a spatter and vacuum deposition, and do not necessarily need heat treatment in this case.
[0165] In formation of piezo-electricity / electrostriction components 18a and 18b, piezo-electricity / electrostriction components 18a and 18b are beforehand formed in both the front faces of the ceramic Green layered product 58, i.e., each front face of the ceramic green sheets 52A and 52B, and calcinating this ceramic Green layered product 58, and the piezo-electricity / electrostriction components 18a and 18b to coincidence is also performed preferably. If in charge of coincidence baking, it may be made to calcinate to all the configuration film of the ceramic Green layered product 58, and the piezo-electricity / electrostriction components 18a and 18b, and coincidence baking of one electrode 24 and ceramic Green layered product 58 is carried out, or the approach of carrying out coincidence baking of other configuration film and ceramic Green layered products 58 except the electrode 26 of another side etc. is mentioned.
[0166] As an approach of carrying out coincidence baking of piezo-electricity / electrostriction components 18a and 18b, and the ceramic Green layered product 58 The precursor of piezo-electricity / electrostriction layer 22 is fabricated by the tape-forming method using a slurry raw material etc. The laminating of the precursor of the piezo-electricity / electrostriction layer 22 before this baking is carried out by thermocompression bonding etc. on the front face of the ceramic Green layered product 58, and the approach of calcinating to coincidence and producing moving part 20a and 20b, the sheet metal sections 12a and 12b, the piezo-electricity / electrostriction layer 22, and a fixed part 14 to coincidence is mentioned. However, it is necessary to form an electrode 24 in the front face of the ceramic Green layered product 58, and/or the piezo-electricity / electrostriction layer 22 beforehand by this approach using the film forming method mentioned above.
[0167] As the other approaches, the electrodes 24 and 26, and the piezo-electricity / electrostriction layer 22 which is each configuration layer of piezo-electricity / electrostriction components 18a and 18b is formed in the part of the ceramic Green layered product 58 which finally serves as the sheet metal sections 12a and 12b at least by screen-stencil, and calcinating to coincidence is mentioned.
[0168] Although the burning temperature of the configuration film of piezo-electricity / electrostriction components 18a and 18b is suitably determined by the ingredient which constitutes this, generally, it is 500 degrees C - 1500 degrees C, and is 1000 degrees C - 1400 degrees C preferably to piezo-electricity / electrostriction layer 22. In this case, in order to control the presentation of piezo-electricity / electrostriction layer 22, it is desirable to sinter under existence of the evaporation source of the ingredient of piezo-electricity / electrostriction layer 22. In addition, to carry out coincidence baking of piezo-electricity / electrostriction layer 22, and the ceramic Green layered product 58, it is required to double both baking conditions. that by which piezo-electricity / electrostriction components 18a and 18b are not necessarily formed in both sides of the ceramic layered product 60 or the ceramic Green layered product 58 -- it is not -- one side -- it is easy to be natural.
[0169] Next, an unnecessary part is excised among the ceramic layered products 60 in which piezo-electricity / electrostriction components 18a and 18b were formed as mentioned above. The locations to excise are the flank of the ceramic layered product 60, and a part (a cutting plane line C1 and C2 reference) where the pore 42 by the window part 54 is especially formed in the side face of the ceramic layered product 60 of this excision.
[0170] Subsequently, as shown in drawing 19 , core part 20c of the part which serves as moving part 20a and 20b is cut and removed along with cutting plane lines C3 and C4, and the piezo-electricity / electrostriction device 10 with which piezo-electricity / electrostriction components 18a and 18b were formed in ceramic base 16C by which the fixed part 14 was united with moving part 20a and 20b, sheet metal section 12a, and 12b list are produced. As the approach of excision, it is possible to apply laser beam machining and electron beam machining of dicing processing, wire saw processing, etc., such as an YAG laser besides machining and excimer laser.
[0171] Moreover, it will be processed into logging of ceramic base 16C combining these processing approaches. For example, as for cutting plane lines C1 and C2 (refer to drawing 18), it is desirable to consider as wire saw processing and to consider the end faces 34a and 34b of the fixed part 14 which intersects perpendicularly with cutting plane lines C1 and C2, and moving part 20a and 20b as dicing processing.
[0172] By the way, it sets to the 1st manufacture approach of of above-mentioned piezo-electricity / electrostriction device 10. Since he is trying to really form piezo-electricity / electrostriction components 18a and 18b on sheet metal section 12a and 12b by baking, As shown in drawing 20 A, in the contraction of piezo-electricity / electrostriction layer 22 and the electrodes 24 and 26 of a pair which are produced at the time of baking, and piezo-electricity / electrostriction layer 22 list by the difference in coefficient of thermal expansion with the sheet metal sections 12a and 12b etc. In sheet metal section 12a and 12b list, for example, piezo-electricity / electrostriction components 18a and 18b It displaces slightly so that it may become a convex toward a pore 42, and it will be in the condition that distortion arose

geometrically, and will become easy to generate internal residual stress in piezo-electricity / electrostriction components 18a and 18b (especially piezo-electricity / electrostriction layer 22), or the sheet metal sections 12a and 12b.
[0173] Generating of the internal residual stress in these sheet metal sections 12a and 12b, or the piezo-electricity / electrostriction layer 22 is produced also when really which was mentioned above sticking the piezo-electricity / electrostriction components 18a and 18b of another object on the sheet metal sections 12a and 12b besides baking with adhesives. That is, in case adhesives are fixed or hardened, internal residual stress will occur by hardening contraction of adhesives etc. in the sheet metal sections 12a and 12b, or the piezo-electricity / electrostriction layer 22. Furthermore, when heating is required, internal residual stress becomes the immobilization or hardening with a big thing.
[0174] If piezo-electricity / electrostriction device 10 is used in this condition, even if it gives predetermined electric field to piezo-electricity / electrostriction layer 22, a desired variation rate may not be shown in moving part 20a and 20b. This is because the material property of piezo-electricity / electrostriction layer 22 and displacement actuation of moving part 20a and 20b are checked by the internal residual stress generated in said sheet metal sections 12a and 12b, or the piezo-electricity / electrostriction layer 22.
[0175] Then, he is trying only for the predetermined width of face W1 (for example, 100 micrometers) to excise core part 20c of moving part 20a and 20b by this 1st manufacture approach, as shown in drawing 20 A. Although the end faces 34a and 34b which counter mutually are formed in moving part 20a and 20b of excision of this core part 20c as shown in drawing 20 B With the internal residual stress generated in the sheet metal sections 12a and 12b, or the piezo-electricity / electrostriction layer 22, it moves in the direction in which these end faces 34a and 34b approach mutually, and the width of face of each end faces 34a and 34b after migration turns into the 2nd short predetermined width of face W2 (for example, 30 micrometers) from said predetermined width of face W1. As for the 2nd predetermined width of face W2, the direction of a tip will become shorter if it explains in full detail more.
[0176] Migration of these end faces 34a and 34b is followed on release of the internal residual stress generated in the sheet metal sections 12a and 12b, or the piezo-electricity / electrostriction layer 22. Where internal residual stress is released, when piezo-electricity / electrostriction device 10 is used, moving part 20a and 20b will show the displacement actuation as a design mostly, and will show a good device property. As this effectiveness excises a part of part used as a fixed part 14, for example, shows it to drawing 11 When the end faces 34a and 34b which counter a fixed part 14 mutually are formed, are the same. In this case The internal residual stress generated in the sheet metal sections 12a and 12b, or the piezo-electricity / electrostriction layer 22 will be released by migration of the end faces 34a and 34b which were formed in the fixed part 14 and which counter mutually. In addition, about the end faces 34a and 34b which counter, the same effectiveness is not necessarily acquired not only excision for a core of moving part 20a and 20b or a fixed part 14 but by excising and forming the part which swerved from the core.
[0177] It is desirable to heat-treat at 300 degrees C - 800 degrees C after excision in excision shown in drawing 18 or excision shown in drawing 19 . This is because said defect can be removed and dependability improves by said heat treatment, although it is easy to produce defects, such as a micro crack, in piezo-electricity / electrostriction device 10 by processing. Furthermore, it is desirable to leave it at the temperature of about 80 degrees C after said heat treatment for about at least 10 hours, and to perform aging processing. It is because the various stress received in the manufacture process can be eased further and it contributes to improvement in a property by this aging processing.
[0178] Next, it explains, referring to drawing 21 - drawing 24 about the 2nd manufacture approach. First, the ceramic green sheets 50A-50D of two or more sheets (for example, four sheets) with which the window part 54 for forming space between sheet metal section 12a and 12b at least was formed as shown in drawing 21 , The ceramic green sheets 102A-102G of two or more sheets (for example, seven sheets) with which continuation formation of the window part 100 for forming the window part 54 for forming space between sheet metal section 12a and 12b and the moving part 20a and 20b which has the end faces 34a and 34b which counter mutually was carried out, The ceramic green sheets 52A and 52B of two or more sheets (for example, two sheets) used as the sheet metal sections 12a and 12b are prepared for behind.
[0179] Then, as are shown in drawing 22 , and 102A-102G are put between ceramic green sheet 50A - 50D list with the ceramic green sheets 52A and 52B, the laminating and sticking by pressure of 102A-102G are done, and it considers as the ceramic Green layered product 58 at these ceramic green sheets 50A-50D, 52A, and 52B list. In this laminating, the ceramic green sheets 102A-102G are located in the center, and carry out a laminating. Since the part which does not require a pressure at the time of sticking by pressure occurs by existence of a window part 100 at this time, a laminating, the sequence of sticking by pressure, etc. are changed and it is necessary to make it such a part not generated. This is the same also by the 3rd and 4th manufacture approaches mentioned later. Then, the ceramic Green layered product 58 is calcinated and the ceramic layered product 60 (refer to drawing 23) is obtained.
[0180] Next, the piezo-electricity / electrostriction components 18a and 18b of multilayer structure are formed in both

the front faces of said ceramic layered product 60, i.e., the front face on which the ceramic green sheets 52A and 52B are equivalent to the front face by which the laminating was carried out, respectively, and piezo-electricity / electrostriction components 18a and 18b are made to unite with the ceramic layered product 60 by baking, as shown in drawing 23 . Of course, piezo-electricity / electrostriction component 10 may be formed only on the surface of one side. This is the same also by the 3rd and 4th manufacture approaches mentioned later.

[0181] Next, the flank and point of the ceramic layered product 60 are excised by cutting along with cutting plane lines C1, C2, and C5 among the ceramic layered products 60 in which piezo-electricity / electrostriction components 18a and 18b were formed. By this excision, as shown in drawing 24 , the piezo-electricity / electrostriction device 10 with which piezo-electricity / electrostriction components 18a and 18b were formed in ceramic base 16C, and the moving part 20a and 20b which has the end faces 34a and 34b which counter mutually was formed are obtained. After cutting the timing of cutting along with cutting plane lines C1 and C2, it may be cut along with a cutting plane line C5, and after cutting along with a cutting plane line C5, it may be cut along with cutting plane lines C1 and C2. Of course, it may be made to perform these cutting to coincidence. Moreover, you may make it also cut suitably the end face of a cutting plane line C5 and the fixed part 14 which counters.

[0182] In this 2nd manufacture approach, at the same time it excised the unnecessary part from the ceramic layered product 60 Since the piezo-electricity / electrostriction device 10 with which piezo-electricity / electrostriction components 18a and 18b were formed in ceramic base 16C, and the moving part 20a and 20b which has the end faces 34a and 34b which counter mutually was formed can be obtained, While being able to attain simplification of a production process, the yield of piezo-electricity / electrostriction device 10 can be raised. In this case, it is desirable, especially in case two or more piezo-electricity / electrostriction devices 10 are arranged in a lengthwise direction and a longitudinal direction, respectively, and a large number are taken and it carries out at the same process into the same substrate. Compared with the 1st manufacture approach, it is because it is easy to process much formation of end faces 34a and 34b at the same process.

[0183] Next, it explains, referring to drawing 25 - drawing 28 about the 3rd manufacture approach. First, the ceramic green sheets 50A-50D of two or more sheets (for example, four sheets) with which the window part 54 for forming space between sheet metal section 12a and 12b at least was formed as shown in drawing 25 , Continuation formation of the window part 104 for forming partial 20D (referring to drawing 28) which serves as the moving part 20a and 20b where the end faces 34a and 34b which counter mutually were connected with the window part 54 for forming space between sheet metal section 12a and 12b in part is carried out. The ceramic green sheets 108A-108G of two or more sheets (for example, seven sheets) which were jutted out in part toward the window part 54 and with which it ****ed and the section 106 was formed, and the ceramic green sheets 52A and 52B of two or more sheets (for example, two sheets) which serve as the sheet metal sections 12a and 12b behind are prepared.

[0184] Then, as shown in drawing 26 , as the ceramic green sheets 50A-50D, and 108A-108G are put with the ceramic green sheets 52A and 52B, the laminating and sticking by pressure of these ceramic green sheets 50A-50D, 52A, and 52B, 108A-108G are done, and it considers as the ceramic Green layered product 58. In this laminating, the ceramic green sheets 108A-108G are located in the center, and carry out a laminating. Then, the ceramic Green layered product 58 is calcinated and the ceramic layered product 60 (refer to drawing 27) is obtained.

[0185] Next, the piezo-electricity / electrostriction components 18a and 18b of multilayer structure are formed in both the front faces of said ceramic layered product 60, i.e., the front face on which the ceramic green sheets 52A and 52B are equivalent to the front face by which the laminating was carried out, respectively, and piezo-electricity / electrostriction components 18a and 18b are made to unite with the ceramic layered product 60 by baking, as shown in drawing 27 .

[0186] Next, the flank and point of the ceramic layered product 60 are excised by cutting along with cutting plane lines C1, C2, and C5 among the ceramic layered products 60 in which piezo-electricity / electrostriction components 18a and 18b were formed. Although piezo-electricity / electrostriction components 18a and 18b are formed by this excision at a fixed part 14, sheet metal section 12a, and 12b list as shown in drawing 28 , partial 20D which serves as moving part 20a and 20b is in the condition that the end faces 34a and 34b which counter mutually ****ed, and the part was connected by the section 106.

[0187] Next, said overhang section 106 which has connected in part the end faces 34a and 34b which counter mutually is excised, and the piezo-electricity / electrostriction device 10 with which piezo-electricity / electrostriction components 18a and 18b were formed in ceramic base 16C by which the fixed part 14 was united with moving part 20a and 20b, sheet metal section 12a, and 12b list are produced.

[0188] In this 3rd manufacture approach, in a culmination, since what is necessary is just to excise the thin overhang section 106 which has connected in part the end faces 34a and 34b which counter mutually, while being able to excise

simply and certainly and being able to attain simplification of a production process, the yield of piezo-electricity / electrostriction device 10 can be raised.

[0189] Next, it explains, referring to drawing 29 - drawing 32 about the 4th manufacture approach. First, the ceramic green sheets 50A-50D of two or more sheets (for example, four sheets) with which the window part 54 for forming space between sheet metal section 12a and 12b at least was formed as shown in drawing 29 , The window part 104 for forming partial 20D (referring to drawing 32) which serves as the moving part 20a and 20b where the end faces 34a and 34b which counter mutually were connected with the window part 54 for forming space between sheet metal section 12a and 12b in part is formed. a window part 54 and a window part 104 are separated -- as -- a crosspiece -- the ceramic green sheets 114A-114G of two or more sheets (for example, seven sheets) with which the section 112 was formed, and the ceramic green sheets 52A and 52B of two or more sheets (for example, two sheets) which serve as the sheet metal sections 12a and 12b behind are prepared.

[0190] Then, as shown in drawing 30 , as the ceramic green sheets 50A-50D, and 114A-114G are put with the ceramic green sheets 52A and 52B, the laminating and sticking by pressure of these ceramic green sheets 50A-50D, 52A, and 52B, 114A-114G are done, and it considers as the ceramic Green layered product 58. In this laminating, the ceramic green sheets 114A-114G are located in the center, and carry out a laminating. Then, the ceramic Green layered product 58 is calcinated and the ceramic layered product 60 (refer to drawing 31) is obtained.

[0191] Next, the piezo-electricity / electrostriction components 18a and 18b of multilayer structure are formed in both the front faces of said ceramic layered product 60, i.e., the front face on which the ceramic green sheets 52A and 52B are equivalent to the front face by which the laminating was carried out, respectively, and piezo-electricity / electrostriction components 18a and 18b are made to unite with the ceramic layered product 60 by baking, as shown in drawing 31 .

[0192] Next, the flank and point of the ceramic layered product 60 are excised by cutting along with cutting plane lines C1, C2, and C5 among the ceramic layered products 60 in which piezo-electricity / electrostriction components 18a and 18b were formed. the end faces 34a and 34b which partial 20D which serves as moving part 20a and 20b counters mutually although piezo-electricity / electrostriction components 18a and 18b are formed by this excision at a fixed part 14, sheet metal section 12a, and 12b list as shown in drawing 32 -- a crosspiece -- it is in the condition that the part was connected by the section 112.

[0193] Next, said **** 112 which has connected in part the end faces 34a and 34b which counter mutually is excised, and the piezo-electricity / electrostriction device 10 with which piezo-electricity / electrostriction components 18a and 18b were formed in ceramic base 16C by which the fixed part 14 was united with moving part 20a and 20b, sheet metal section 12a, and 12b list are produced.

[0194] the crosspiece which has connected in part the end faces 34a and 34b which counter mutually in a culmination in this 4th manufacture approach -- since what is necessary is just to excise the section 112, while being able to excise simply and certainly and being able to attain simplification of a production process, the yield of piezo-electricity / electrostriction device 10 can be raised.

[0195] Although the above-mentioned example showed the example which constituted said moving part 20a and 20b, a fixed part 14, and the sheet metal sections 12a and 12b from ceramic base 16C, each part can also consist of metallic materials. Furthermore, it can also constitute as hybrid construction which combined what was manufactured from the ceramics and a metaled ingredient. In this case, in junction between metallic materials, and junction between the ceramics and a metallic material, the adhesion in organic resin, glass, etc., low attachment, soldering, eutectic bonding, welding, etc. can be used.

[0196] For example, it explains, referring to drawing 33 - drawing 40 about the manufacture approach (the 5th and the 6th manufacture approach) of of the piezo-electricity / electrostriction device of the hybrid construction which used moving part 20a and 20b and a fixed part 14 as the ceramics, and used the sheet metal sections 12a and 12b as the metal (piezo-electricity / electrostriction device 10h concerning the 8th modification). Therefore, the metal formed by these 5th and 6th manufacture approaches and the base containing the ceramics are described as base 16D.

[0197] The ceramic green sheets 50A-50D of two or more sheets (for example, four sheets) with which the window part 54 for the 5th manufacture approach to form space between sheet metal section 12a and 12b at least first as shown in drawing 33 was formed, Between sheet metal section 12a and 12b, space The window part 100 for forming the window part 54 for forming and the moving part 20a and 20b which has the end faces 34a and 34b which counter mutually prepares the ceramic green sheets 102A-102G of two or more sheets (for example, seven sheets) by which continuation formation was carried out.

[0198] Then, as shown in drawing 34 , the laminating and sticking by pressure of the ceramic green sheets 50A-50D, and 102A-102G are done, and it considers as the ceramic Green layered product 158. In this laminating, the ceramic

green sheets 102A-102G are located in the center, and carry out a laminating. Then, the ceramic Green layered product 158 is calcinated, and as shown in drawing 35 , the ceramic layered product 160 is obtained. At this time, it becomes the form where the pore 130 was formed of window parts 54 and 100 at the ceramic layered product 160.
[0199] Next, as shown in drawing 36 , the piezo-electricity / electrostriction components 18a and 18b which were constituted as another object are pasted up on the front face of the metal plates 152A and 152B which serve as the sheet metal sections 12a and 12b, respectively with epoxy system adhesives. The piezo-electricity / electrostriction components 18a and 18b of another object can be formed for example, with a ceramic green sheet laminated layers method.
[0200] Next, as a pore 130 is closed, these metal plates 152A and 152B are pasted up on the ceramic layered product 160 with epoxy system adhesives, and it considers as the hybrid layered product 162 (refer to drawing 37) so that the ceramic layered product 160 may be put with metal plates 152A and 152B.
[0201] Next, as shown in drawing 37 , the flank and point of the hybrid layered product 162 are excised by cutting along with cutting plane lines C1, C2, and C5 among the hybrid layered products 162 in which piezo-electricity / electrostriction components 18a and 18b were formed. By this excision, as shown in drawing 38 , the piezo-electricity / electrostriction device 10h concerning the 8th modification in which piezo-electricity / electrostriction components 18a and 18b were formed in the sheet metal sections 12a and 12b which consisted of metal plates among base 16D, and the moving part 20a and 20b which has the end faces 34a and 34b which counter mutually was formed are obtained.
[0202] On the other hand, first, as shown in drawing 34 , the 6th manufacture approach does the laminating and sticking by pressure of the ceramic green sheets 50A-50D, and 102A-102G, and makes them the ceramic Green layered product 158. Then, the ceramic Green layered product 158 is calcinated, and as shown in drawing 39 , the ceramic layered product 160 is obtained. At this time, it becomes the form where the pore 130 by window parts 54 and 100 was formed at the ceramic layered product 160.
[0203] Next, as shown in drawing 40 , as a pore 130 is closed, these metal plates 152A and 152B are pasted up on the ceramic layered product 160 with epoxy system adhesives, and it considers as the hybrid layered product 162 so that the ceramic layered product 160 may be put with metal plates 152A and 152B. In case piezo-electricity / electrostriction components 18a and 18b are stuck on the front face of the pasted-up metal plates 152A and 152B at this time, as shown in drawing 39 , a pore 130 is filled up with a filler 164 if needed, so that sufficient adhesion pressure may be put.
[0204] Since it is finally necessary to remove a filler 164, it is easy to dissolve in a solvent etc., and it is desirable that it is a hard ingredient, for example, organic resin, a wax, a low, etc. are mentioned. Moreover, the ingredient which mixed ceramic powder as a filler is also employable as organic resin, such as an acrylic.
[0205] Next, as shown in drawing 40 , the piezo-electricity / electrostriction components 18a and 18b which were formed in the front face of the metal plates 152A and 152B in the hybrid layered product 162 as another object are pasted up with epoxy system adhesives. The piezo-electricity / electrostriction components 18a and 18b of another object can be formed for example, with a ceramic green sheet laminated layers method.
[0206] As the rest was mentioned above, it passes through the same process as drawing 37 and drawing 38 . The inside of base 16D, The piezo-electricity / electrostriction device 10h concerning the 8th modification in which piezo-electricity / electrostriction components 18a and 18b were formed in the sheet metal sections 12a and 12b which consisted of metal plates 152A and 152B, and the moving part 20a and 20b which has the end faces 34a and 34b which counter mutually was formed are obtained.
[0207] Moreover, what is necessary is to form the part equivalent to the ceramic layered product 160 in drawing 35 by casting, in using all base 16D as a metal, and also to carry out the laminating of the **-like metal and just to form by the cladding method.
[0208] According to the piezo-electricity / the electrostriction device mentioned above, various transducers, various actuators, A frequency-domain functional part (filter), a transformer, the vibrator and resonator for the object for a communication link, or power, Others, an ultrasonic sensor, and an acceleration sensor, [active elements /, such as a radiator and a discriminator,] It can use as sensor components for [various] sensors, such as an angular-velocity sensor, and an impact sensor, a mass sensor, and can use suitable for the various actuators especially used for the variation rate of various precision components, such as an optical instrument and a precision mechanical equipment, etc., or the device of positioning adjustment and include-angle adjustment.
[0209] In addition, the piezo-electricity / electrostriction device concerning this invention, and its manufacture approach of the ability of various configurations to be taken are natural, without deviating not only from the gestalt of above-mentioned operation but from the summary of this invention.
[0210]
[Effect of the Invention] As explained above, according to the piezo-electricity / electrostriction device concerning this

invention, and its manufacture approach The stability of a device or the attachment nature of the components to moving part can be raised also in lightweight-izing of a device in the handling nature list of lightweight-izing of a fixed part or moving part, and a device. By this While being able to displace moving part greatly, can make improvement in the speed (raise in resonance frequency) of displacement actuation of moving part attain, moreover, are hard to be influenced of a harmful vibration, and a high-speed response is possible. A mechanical strength is high and can obtain the displacement component excellent in handling nature, shock resistance, and moisture resistance, and the sensor component which can detect vibration of moving part with a sufficient precision in a list.

[Translation done.]

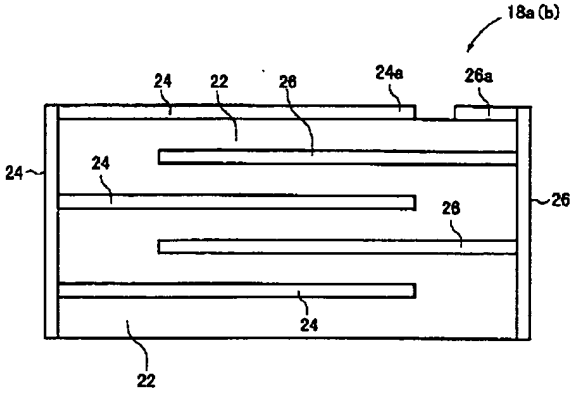
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

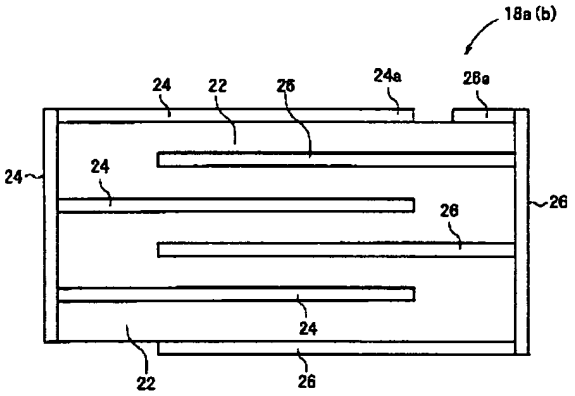
[Drawing 2]

FIG. 2



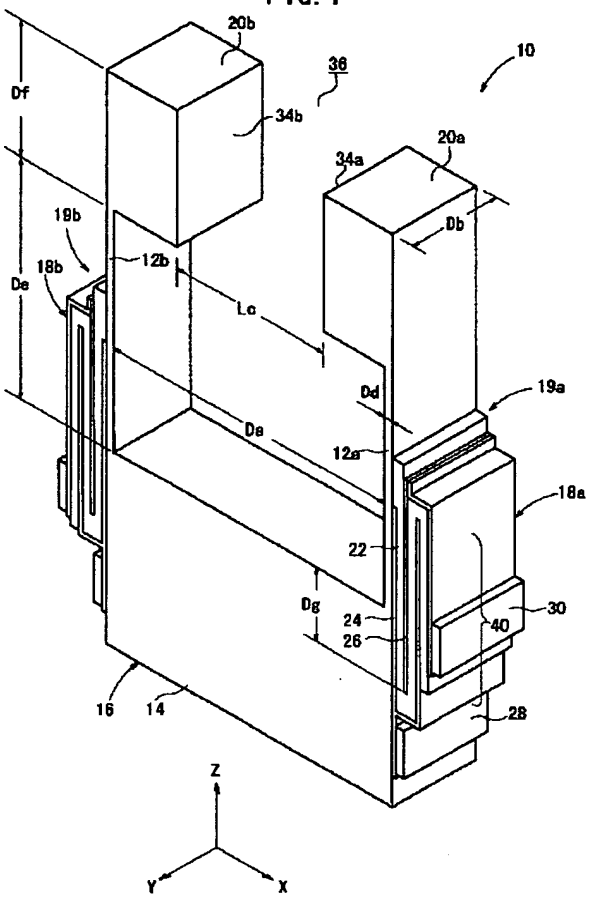
[Drawing 3]

FIG. 3



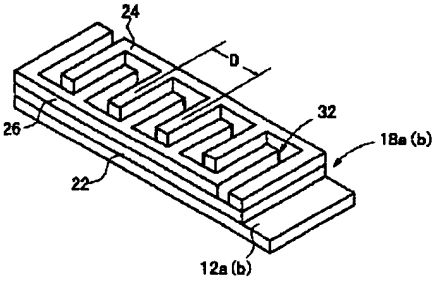
[Drawing 1]

FIG. 1



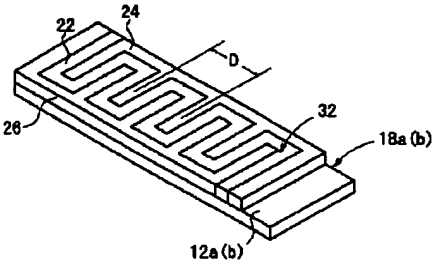
[Drawing 4]

FIG. 4



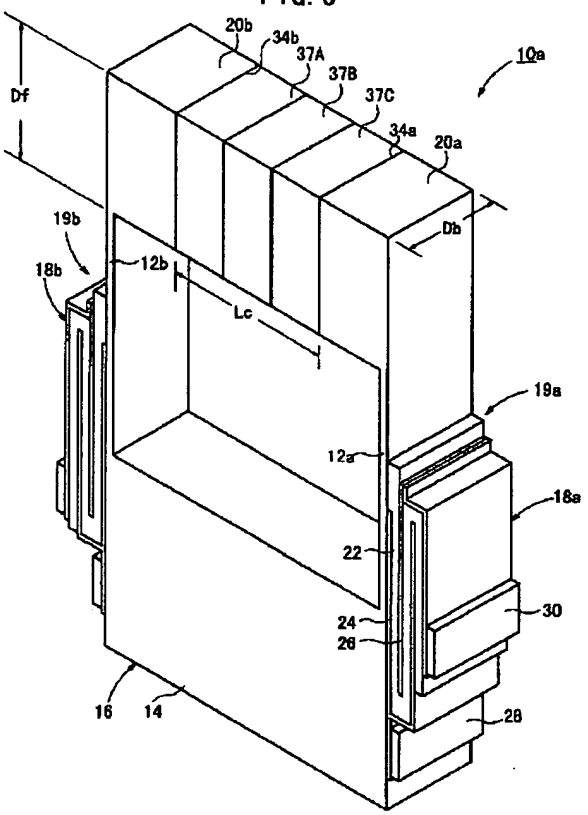
[Drawing 5]

FIG. 5



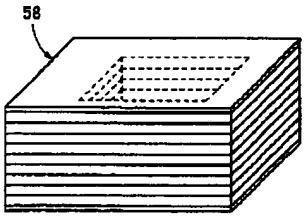
[Drawing 6]

FIG. 6



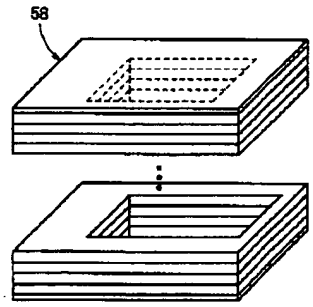
[Drawing 17]

FIG. 17



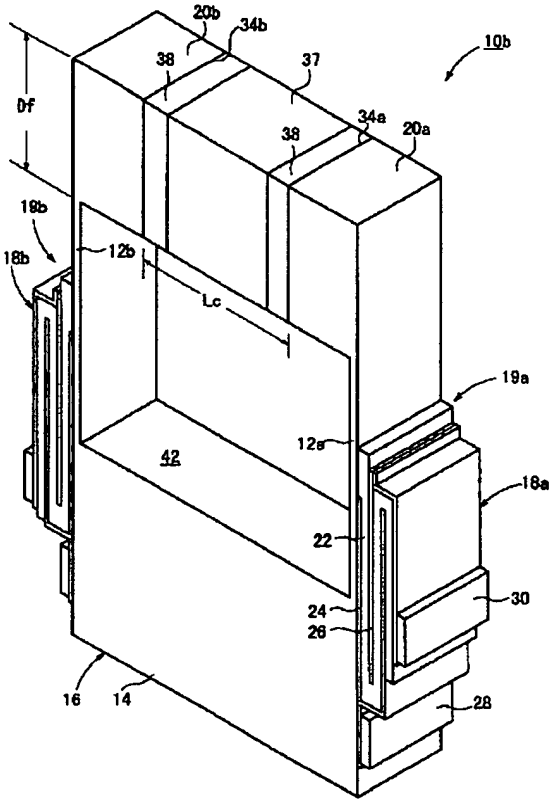
[Drawing 22]

FIG. 22



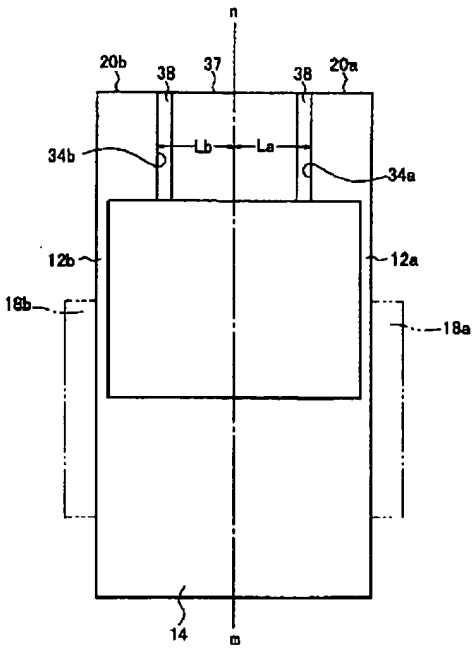
[Drawing 7]

FIG. 7



[Drawing 8]

FIG. 8



[Drawing 9]

FIG. 9A

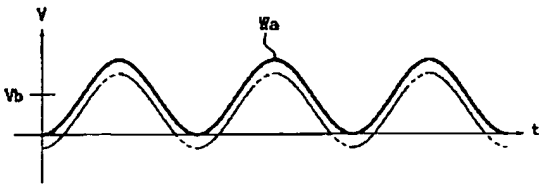
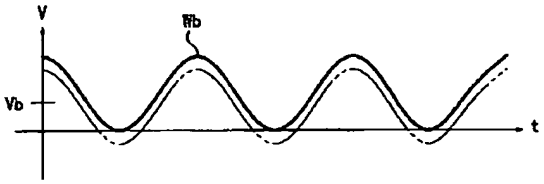
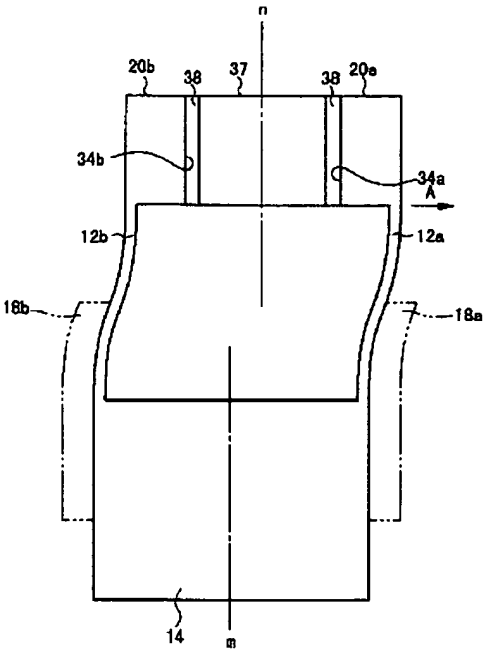


FIG. 9B



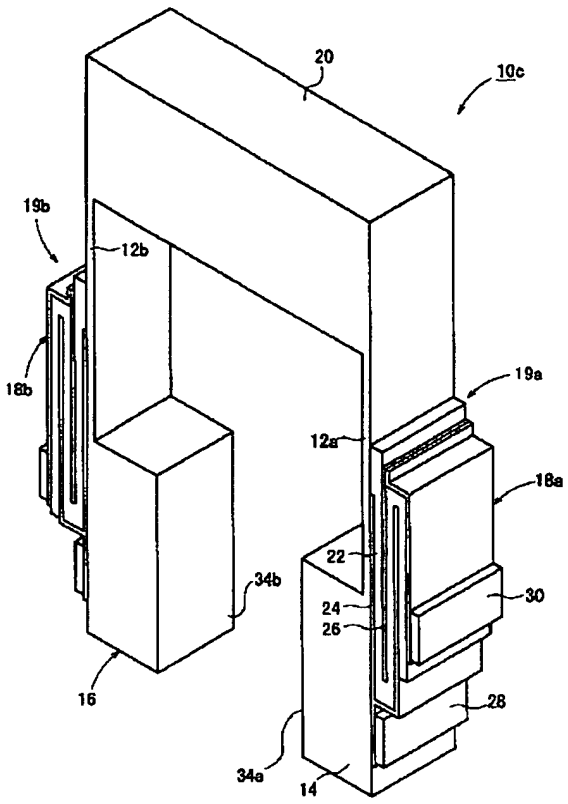
[Drawing 10]

FIG. 10



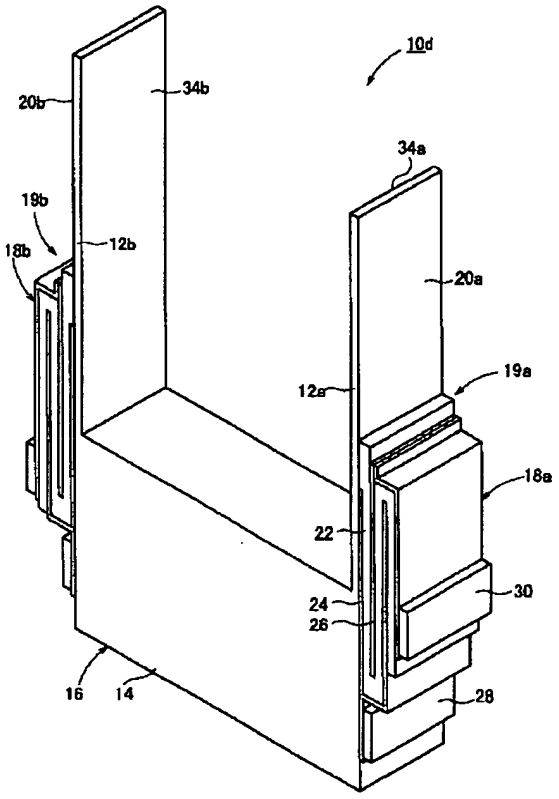
[Drawing 11]

FIG. 11



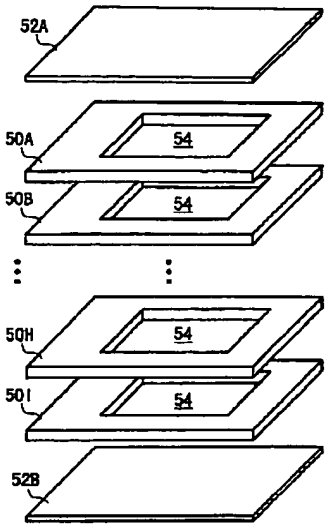
[Drawing 12]

FIG. 12



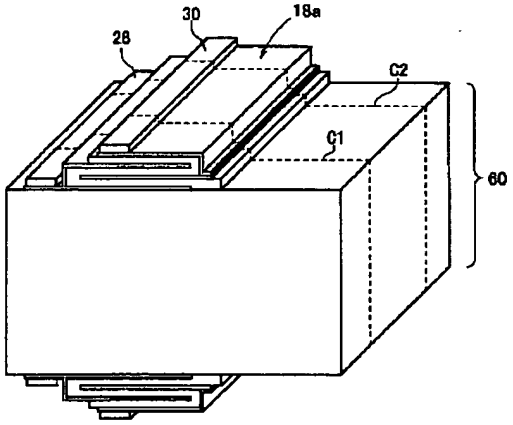
[Drawing 16]

FIG. 16



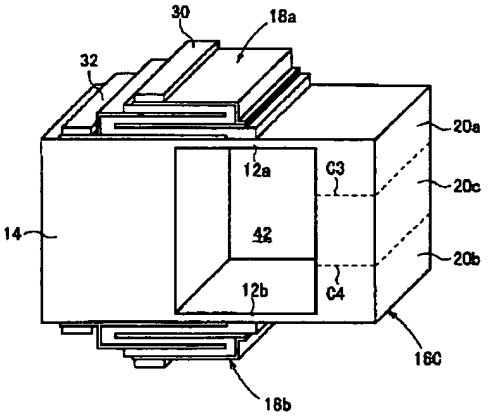
[Drawing 18]

FIG. 18



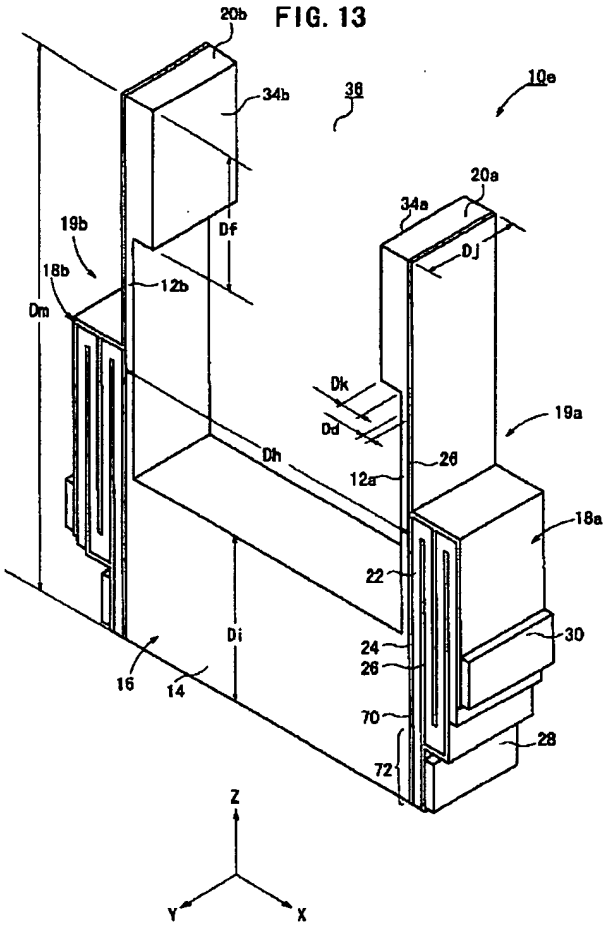
[Drawing 19]

FIG. 19



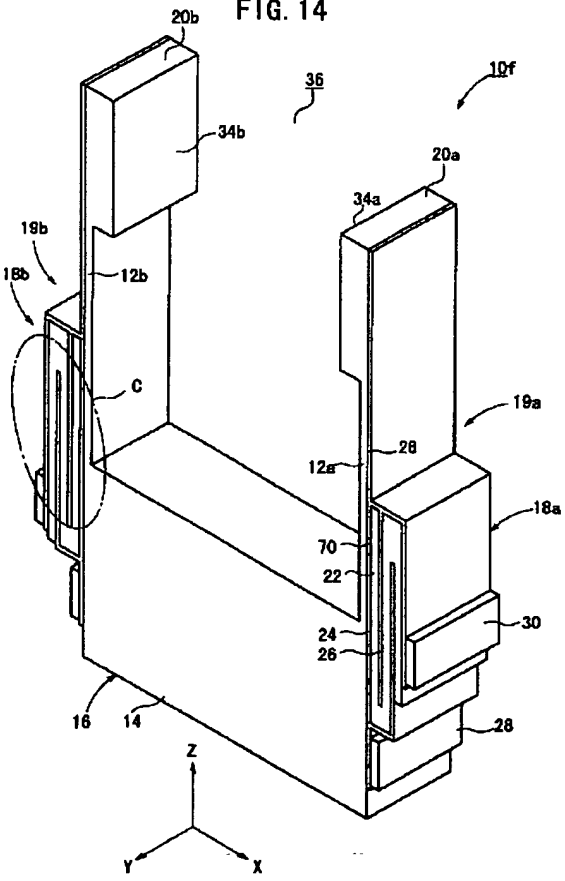
[Drawing 13]

FIG. 13



[Drawing 14]

FIG. 14



[Drawing 20]

FIG. 20A

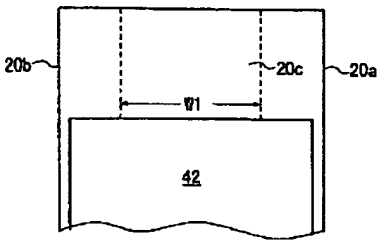
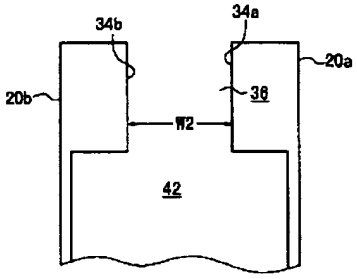
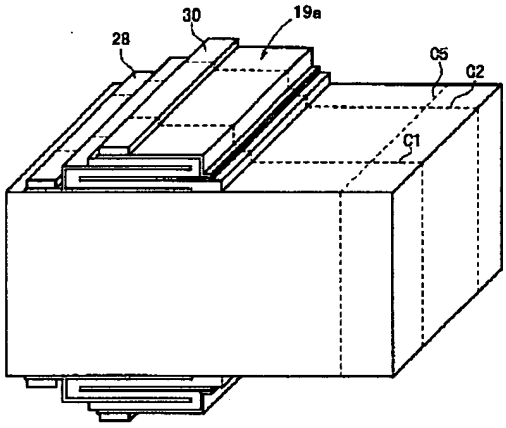


FIG. 20B



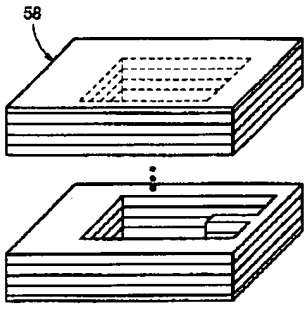
[Drawing 23]

FIG. 23



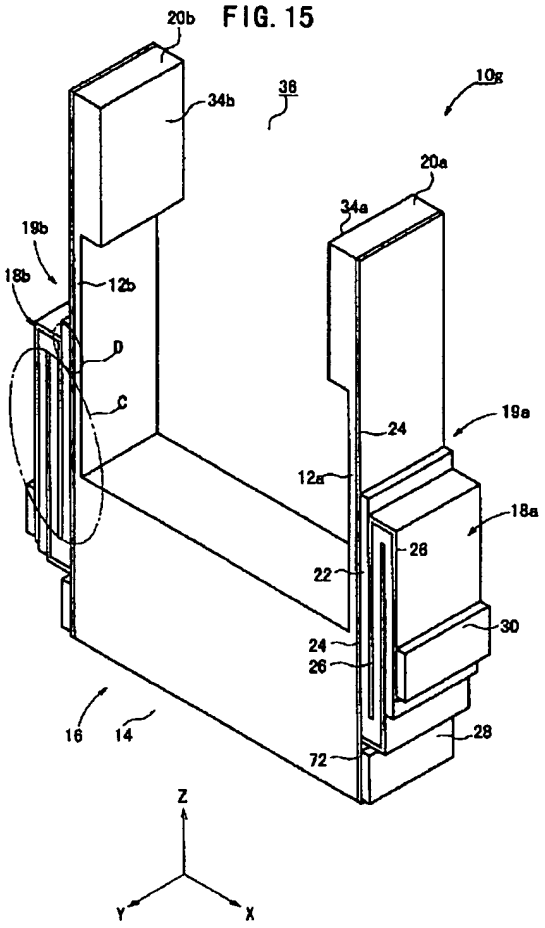
[Drawing 26]

FIG. 26



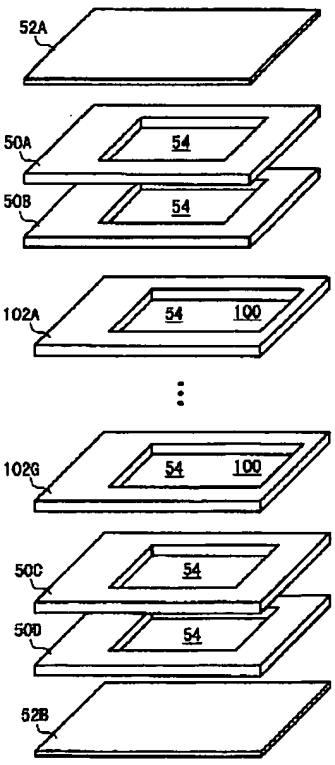
[Drawing 15]

FIG. 15



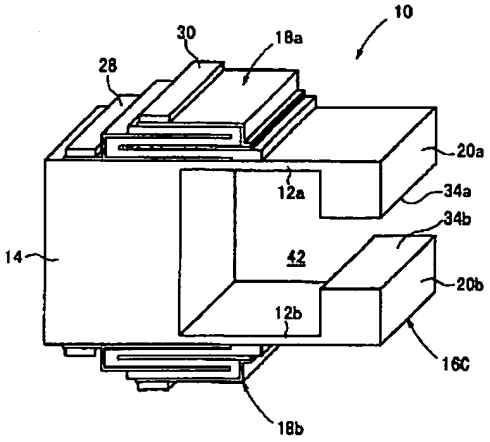
[Drawing 21]

FIG. 21



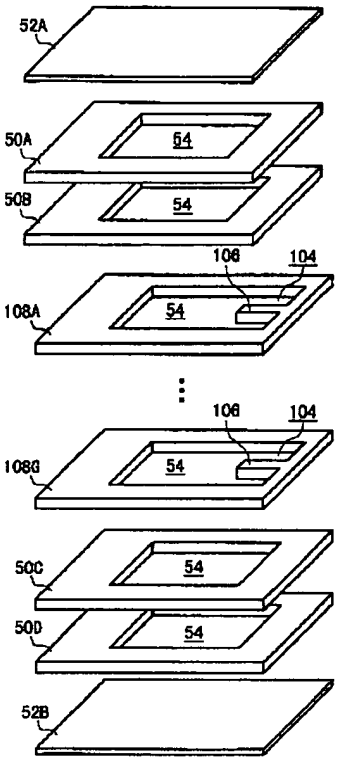
[Drawing 24]

FIG. 24



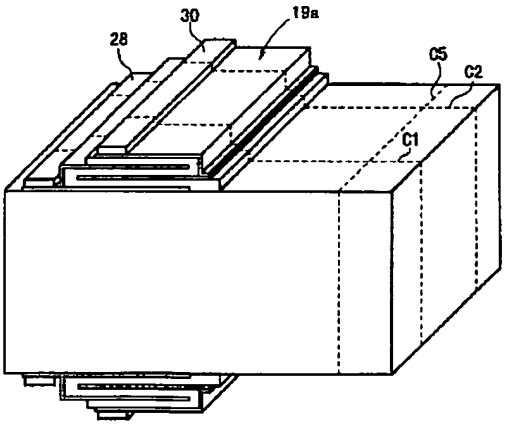
[Drawing 25]

FIG. 25



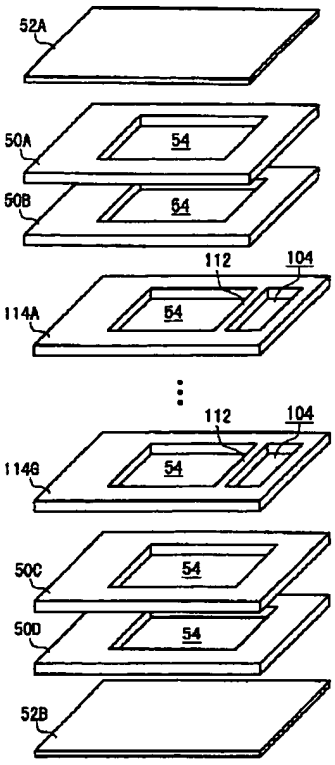
[Drawing 27]

FIG. 27



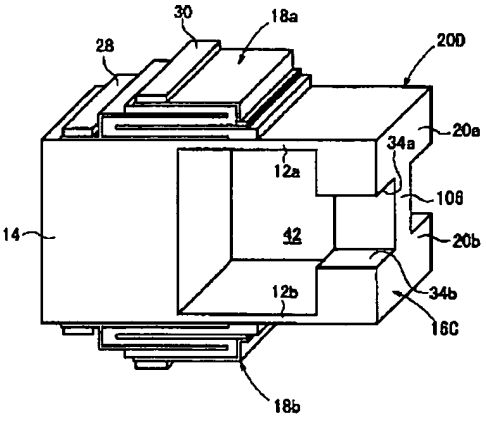
[Drawing 29]

FIG. 29



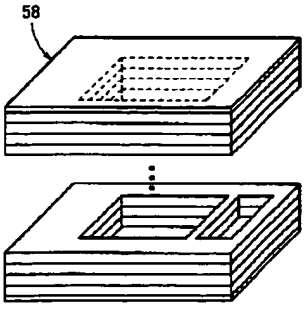
[Drawing 28]

FIG. 28



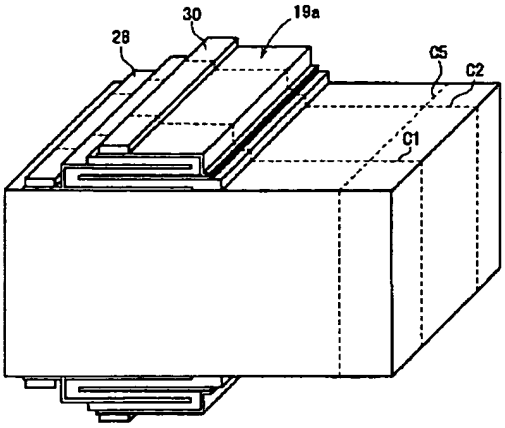
[Drawing 30]

FIG. 30



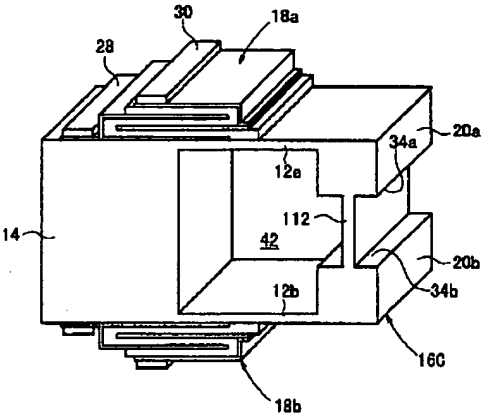
[Drawing 31]

FIG. 31



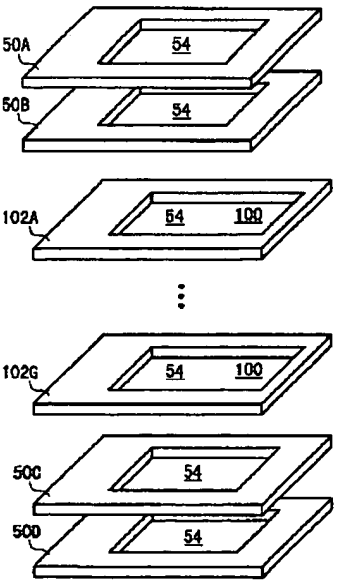
[Drawing 32]

FIG. 32



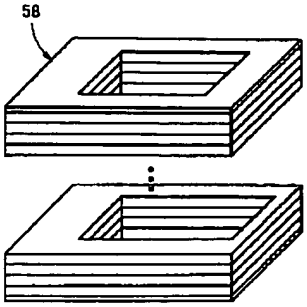
[Drawing 33]

FIG. 33



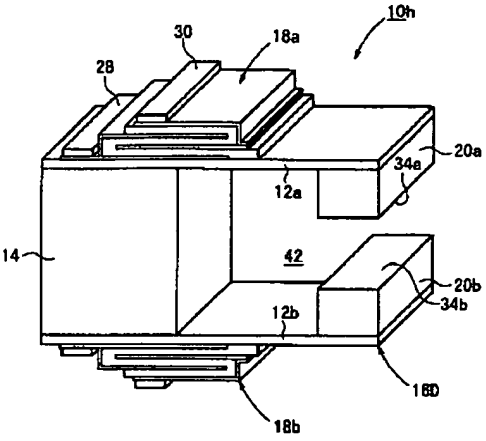
[Drawing 34]

FIG. 34



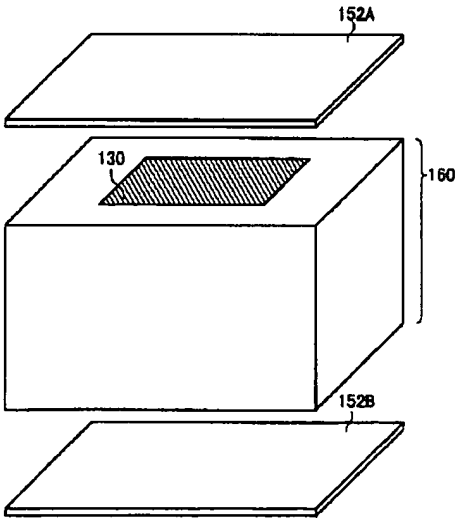
[Drawing 38]

FIG. 38



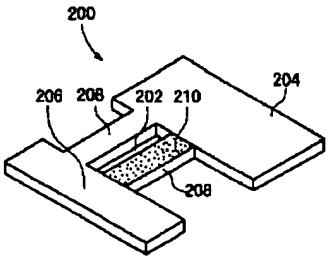
[Drawing 39]

FIG. 39



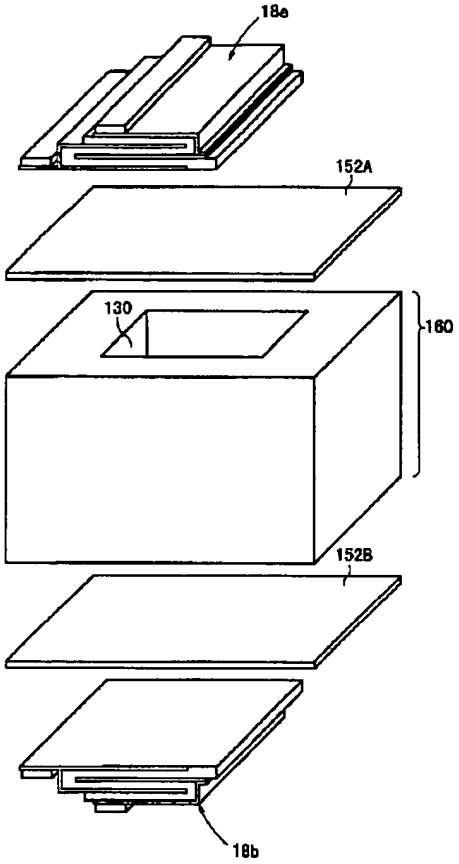
[Drawing 41]

FIG. 41



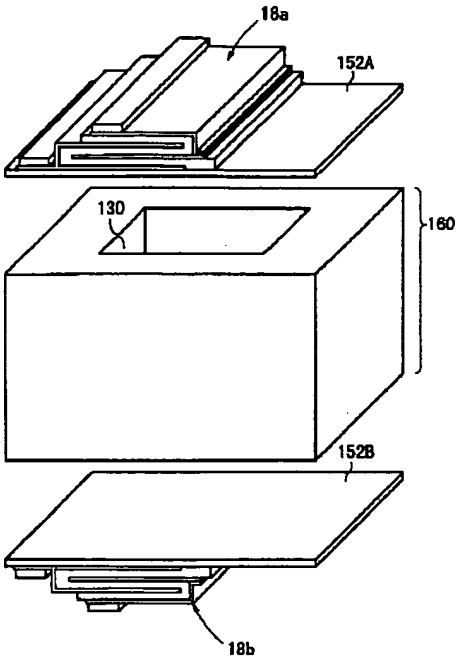
[Drawing 35]

FIG. 35



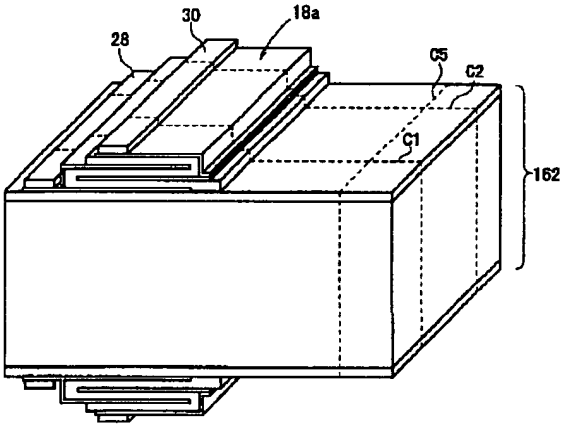
[Drawing 36]

FIG. 36



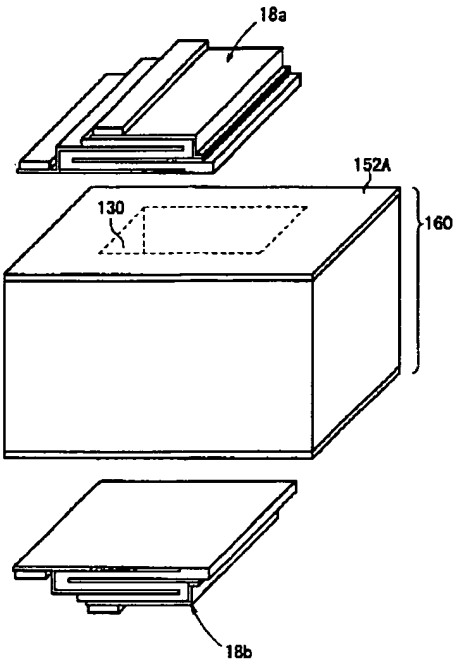
[Drawing 37]

FIG. 37



[Drawing 40]

FIG. 40



[Translation done.]